JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 23 NOVEMBER 14, 1942 NO. 4

RECORDS OF THE ATLANTIC WALRUS AND THE POLAR BEAR IN OR NEAR THE NORTHERN PART OF THE GULF OF ST. LAWRENCE

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It is thought that publication of a number of records of the Atlantic walrus, *Odobenus rosmarus* (Linnaeus), and the polar bear, *Thalarctos maritimus* (Phipps), in or near the northern part of the Gulf of St. Lawrence, with brief comment on certain records previously published, may serve to clarify the status of these arctic maritime mammals in that region. The records here published for the first time were obtained from local residents of the region by Lewis in the summer of 1940 by means of systematic personal inquiry in the scattered coastal communities there. Many of the narrators were chief actors in the occurrences described and many are well known to Lewis, who has had 20 summers of field experience in that region. All of these newly-published occurrences took place within the past 60 years; that is, within the memory of persons now living. There is no reason to doubt that similar occurrences were at least as frequent prior to 1880 as they have been since that date, but, in a region where written records have seldom been made, the memory of such happenings has usually passed away with those who had personal knowledge of them.

With a view to facilitating location of the places mentioned and to permanency of record despite changes in geographical nomenclature, the approximate latitude and longitude of each place of occurrence is given. All of these places, except as otherwise stated, are in Saguenay County, Quebec.

RECORDS OF WALRUS

Biggar (1924) and other commentators have identified as walruses the animals that Jacques Cartier, the famous French explorer, found in great number in the estuary of the Moisie River (Lat. 50° 12′ N., Long. 66° 4′ W.) in 1535, on the day that he knew as August 20, but that in new style reckoning was August 30. These animals are described by Cartier (Biggar, *op. cit.*) as having been "fish, in appearance like horses, which go on land at night but in the day-time remain in the water, as our two Indians informed us." It should be noted that in the summer of 1534 Cartier, when exploring the Magdalen Islands, undoubtedly had found walruses which he described, quite recognizably, as "great beasts, like

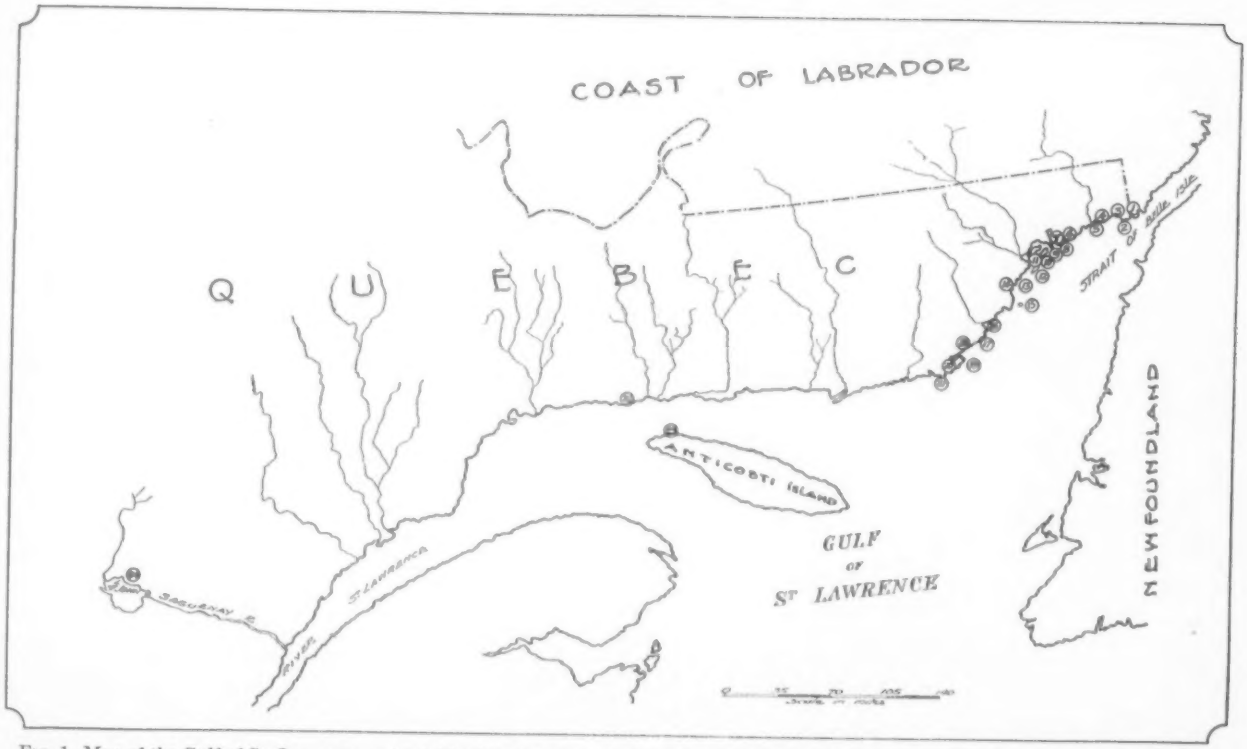

FIG. 1. Map of the Gulf of St. Lawrence and neighboring regions. Points of Occurrence of Polar Bears and Walrus are Indicated by Numbers as set forth hereunder: 1. L'Anse Eclair, 2. Greenly Island, 3. Bradore Bay, 4. Middle Point, 5. Pointe Blanche, 6. Rocky Bay, 7. Napetipi Lake, 8. Napetipi Bay, 9. Anse Portage, 10. Dukes Island, 11. Black Islet, 12. St. Augustin Islands, 13. Kécarpoui, 14. Ha! Ha! Bay, 15. Treble Hill Island, 16. Mouth of (Little) Mecatina River, 17. Harrington Harbour, 18. Watagheistic Sound, 19. Cliff Island, 20. Mouth of Etamamu River, 21. Wolf Bay, 22. Thunder River, 23. Cap de Rabast, 24. Péribonca.

large oxen, which have two tusks in their jaw like elephant's tusks and swim about in the water" (Biggar, *op. cit.*). Because the animals found in the lower Moisie River are described as something new, rather than referred to as beasts of a kind seen in the previous year, and because the description of them differs markedly from the description of the walruses observed in the Magdalen Islands, it seems improbable that these Moisie River creatures were walruses. Probably they were gray seals, *Halichoerus grypus* (Fabricius), which still occur in some numbers in the northwestern part of the Gulf of St. Lawrence and which look so much like horses that the local fishermen speak of them as "horsehead seals."

In June, 1934, Mr. John LeTemplier, then lightkeeper at Greenly Island, observed a sub-adult walrus on the flat sandstone shore of the southwest side of that island (Lat. 51° 22′ N., Long. 57° 12′ W.). Its tusks were large enough to be noticeable. Another man attacked and wounded it, but it escaped.

In the latter part of July, 1932, Mr. J. Bateman and the sons of Mr. Michael Maurice, all of St. Augustin, found a large bull walrus on the islet that forms the harbor point at Anse Portage (Lat. 51° 15′ N., Long. 58° 17′ W.). They attacked this animal with the only weapons at hand, a 12-gauge shot-gun and a .22 rifle, but did not succeed in harming it seriously until, at a distance of only a few feet, they fired at its eyes and destroyed them. The blind walrus promptly plunged into the sea and disappeared.

In late April, 1917, Mr. Jack Belvin, of Lobster Bay, shot and killed a young male walrus on a small island near Bayfield Island, known as Black Islet or Shag Rock (Lat. 51° 11′ N., Long. 58° 22′ W.).

Late in December, about 1910, Mr. James Cox, of Harrington Harbour, caught a large bull walrus in a seal-net set at Cape Airey, Harrington Islands (Lat. 50° 28′ N., Long. 59° 28′ W.). This animal bore many scars and was apparently old. Its tusks were eight or nine inches long. It was about eleven feet in girth, but had little fat. Its stomach contained only a small amount of gravel. This may possibly be the walrus that is recorded by Grenfell (1913) as having been killed near Cape Mekattina (Mecatina) in 1908; also it may be the one referred to by Anderson (1938).

In the month of May, about 1915, Mr. Benjamin Way, of Harrington Harbour, found an adult walrus with conspicuous tusks ashore on Cliff Island (Lat. 50° 18′ N., Long. 59° 41′ W.), one of the St. Mary Islands group. Mr. Way attacked the animal with a small shot-gun, the only weapon that he had with him, but it soon escaped into the sea.

RECORDS OF POLAR BEAR

Polar bears are distinctive and easily recognized. There is a sixteenth-century record of their occurrence, on the north shore of the Gulf of St. Lawrence, that appears to be quite clear. Parkman (1900) has retold from an old manuscript by Thevet the story of Marguerite, niece of the French nobleman Roberval, who was marooned by her uncle on the Isles of Demons or, as they were subsequently called, Les Isles de la Demoiselle, where she remained from 1542 to 1544. These islands were some of those that fringe the north shore of the gulf. In a

previous publication (Lewis, 1934) they are identified as the present Harrington Islands (Lat. 50° 30′ N., Long. 59° 28′ W.). During her enforced stay at this place, Marguerite, who was provided with a musket and ammunition, lived to a large extent on the wild life about her and is said to have killed three bears, all "as white as an egg."

The track of a polar bear, found near the little village of L'Anse Eclair, Newfoundland Labrador (Lat. 51° 25′ N., Long. 57° 4′ W.), revealed that one of these animals landed there from drift ice early in May, 1940, and travelled northward (inland). The track was followed, but the bear was not seen.

An old male polar bear was killed by a Mr. Etheridge at Bradore Bay (Lat. 51° 28′ N., Long. 57° 15′ W.), in February, 1896, as it was attempting to go ashore from drift ice.

A polar bear landed from drift ice on Middle Point, on the east side of Middle Bay (Lat. 51° 26′ N., Long. 57° 29′ W.), in May, in one of the years from 1928 to 1930. It was promptly attacked and fled back to the drift ice.

At Pointe Blanche or Little Fishery (Lat. 51° 26′ N., Long. 57° 33′ W.), a polar bear landed from drift ice in the month of April, in 1931 or 1932. It also was promptly attacked and fled to the drift ice.

In late April, 1920, Mr. Jack Belvin, of Lobster Bay, found near Rocky Bay (Lat. 51° 19′ N., Long. 58° 2′ W.) the track of a polar bear going east along the coast. He followed it. The bear went to Whale Island, near Bonne Esperance, where Philip Griffin fired at it and wounded it. The bear fell or plunged into the water and was not seen again.

About March 1, 1920, Mr. Jack Wellman, of Lobster Bay, killed a large polar bear on the ice on Napetipi Lake (Lat. 51° 24′ N., Long. 58° 2′ W.), which is close to the shore. The bear was travelling north when found and was believed to have come to the vicinity on drift ice.

About 1930, two polar bears were seen near the mouth of Napetipi Bay (Lat. 51° 17′ N., Long. 58° 9′ W.) by Captain Llewellyn Keans, of Bonavista Bay, Newfoundland, who, with his schooner and crew, had come to that vicinity to fish for cod. As Captain Keans and several of his men were on their way in a motorboat, one day in early June, to one of his cod-traps, they saw these bears, an adult and a young one, together on the shore. There was drift ice offshore at the time. When the motorboat approached the bears, they entered the water. Captain Keans made repeated attempts to slip a noose over the head of either the adult bear or the young one, but without success. Each time that the motorboat approached the bears, the adult would push the young one to an inaccessible position under its breast and would, with its paw, skilfully ward off the noose. At last, the motorboat having been incautiously brought too near the bears, the adult bear broke out a large piece of the gunwale with a blow of its paw. After that the bears were left in peace.

In the last week of June, 1939, Mr. Peter Leon, of St. Augustin, found a medium-sized polar bear robbing his salmon net, one end of which was made fast to the southern shore of Dukes Island (Lat. 51° 12′ N., Long. 58° 20′ W.). When Mr. Leon's motorboat approached the spot, the bear fled northward over the island. Mr. Leon thinks that this is probably the same animal hereinafter

recorded as killed at Treble Hill Island in July, 1939, but this view is not at all certain.

On or near April 20, in about the year 1910, a polar bear was seen on ice outside St. Augustin Islands (Lat. 51° 10′ N., Long. 58° 25′ W.). It was pursued, but not killed, for it went northeastward across some small islands and then across a bay where the ice was so unsafe that the pursuers would not attempt to cross it.

In March, about 1934, some Montagnais Indians of the St. Augustin band, travelling overland from Sandwich Bay, on the Atlantic coast of the Labrador Peninsula, to St. Augustin, met in the interior a polar bear going in the opposite direction and killed it with rifles. They took its skin to St. Augustin. The exact place where this bear was encountered is not known.

In the last week of July, 1939, a nearly half grown male polar bear was found on Treble Hill Island (Lat. 50° 50′ N., Long. 58° 44′ W.) by Wallace Collier and three other young men. When discovered, it plunged into the sea, where it was shot to death. It was found to be suffering from two wounds received previously. Examination of the island revealed that the bear had evidently been there for some time and had dug up the ground in various places to obtain Puffins, *Fratercula arctica* (Linnaeus), from their burrows. This account, obtained direct from Wallace Collier, corrects, in some details, a statement that was erroneously supplied to Doutt and recorded by him in the Journal of Mammalogy, vol. 21, p. 91, where it is stated that this bear was killed in May, 1939, on "Grosse Island, sometimes called Mecatina Island."

A medium-sized male polar bear was killed in late February, in about the year 1885, at Kécarpoui (Lat. 51° 1′ N., Long. 58° 49′ W.), as is clearly recalled by Mr. and Mrs. Jacob Monger, who lived at Ha! Ha! Bay, a few miles distant. The bear appeared to have come from drift ice and was trying to get out of the water onto the fixed ice in a bay.

Mr. Jacob Monger has seen the track of a polar bear at Ha! Ha! Bay (Lat. 51° N., Long. 58° 57′ W.) on three different occasions, namely, about 1895, about 1914, and about 1927. In each case the track indicated that the bear had come from the drift ice and had made its way inland.

In February, about the year 1927, Mr. James Monger, of Whale Head, found the track of a polar bear near the mouth of the Little Mecatina River (Lat. 50° 39′ N., Long. 59° 24′ W.). The track indicated that the bear had come directly out from the interior and had made for the sea. Mr. Monger followed it for some ten miles, across sheltered, frozen channels and over part of Little Mecatina Island to Cape Mackinnon, where the bear had evidently plunged into the sea. There was no ice off Cape Mackinnon at the time. The bear was not seen.

In the spring, probably in May, about the year 1910, Mr. John Anderson, of Harrington Harbour, saw a polar bear eating a seal on a pan of ice that was drifting westward a short distance west of Johnson's Passage (Lat. 50° 29′ N., Long. 59° 28′ W.), one of the entrances to that harbor. Mr. Anderson went for help to hunt the bear, but, when he returned with others to find it, it had disappeared, leaving the remains of its meal.

Residents of Harrington Harbour distinctly recall that "many years ago" a

polar bear appeared at Watagheistic Sound (Lat. 50° 24′ N., Long. 59° 50′ W.), now uninhabited, but at that time the place of residence of one family.

Messrs. Edmond and Emile Blais, about forty years of age, living at the mouth of the Etamamu River (Lat. 50° 16′ N., Long. 59° 59′ W.) say that they cannot recall any local occurrence of a polar bear in their lifetime but that one occurred at this place during the lifetime of their father, Mr. Joseph Blais, who in 1940 was believed to be more than eighty years old and was too ill to be interviewed.

Mr. Fred Jones, a retired mail-carrier living at Harrington Harbour, once saw the tracks of three polar bears on the ice on a lake near Wolf Bay (Lat. 50° 14′ N., Long. 60° 13′ W.). This occurred "years ago", but how many years ago and in what month is uncertain.

Messrs. Reuben and Frank Jones of Wolf Bay know of only one actual observation of a polar bear there. They agree that this took place probably in May, about 1895. No drift ice was present at the time. The bear, which was seen only in the water close to shore, was first sighted by the late Gilbert Jones, brother of Reuben and Frank, who called out to Reuben. The latter ran with a gun to a steep rocky point where he expected the bear to pass within range, but the bear dived before it reached him and gave no opportunity for a shot, though he clearly saw the animal swimming seaward beneath the surface of the water.

Inquiry revealed only one record of a polar bear on the actual north shore of the St. Lawrence Gulf and estuary west of Wolf Bay. This bear was seen at Thunder River (Lat. 50° 17′ N., Long. 64° 48′ W.), in April, 1919. A vivid account of its visit was given by Mr. and Mrs. Joseph Lapierre of that village who are able to date the occurrence accurately because the bear's appearance preceded by only two months the birth of their daughter in June, 1919. The bear came from landward (north) and, disregarding several human beings who were close by, made straight for the sea, passing through Mr. Lapierre's dooryard. Mr. Lapierre, unarmed, was in the yard, but was too surprised and frightened to move. Mrs. Lapierre was in the house and saw the bear through an open doorway. There was snow on the ground and some loose floating ice in the sea. On reaching the shore, the bear plunged straightway into the water and swam seaward (south). It is said that its footprint was 13 inches long and that trappers observed its track in the snow 40 miles inland.

Mr. H. E. Graham, of Port Menier, resident manager of Anticosti Island, states that the only polar bear ever seen on Anticosti was observed in 1922 at Cap de Rabast or North Point (Lat. 49° 57′ N., Long. 64° 9′ W.). It was fired at, but escaped.

Despite differences in dates and in various details, the polar bears above recorded from Thunder River and Anticosti are doubtless the basis of Doutt's published report (Doutt, 1940) of a polar bear that is supposed to have swum from Thunder River to Anticosti. Careful inquiry at these places has revealed no record of a polar bear at either place except the one record at each that is set forth above. It is therefore believed that the actual dates of occurrence are are as above stated and that there is no indication that the polar bear seen on

Anticosti and the one seen at Thunder River are identical. Harrison's report (1939) of a polar bear at Thunder River must also be supposed to be based upon this occurrence in 1919. He said that his "recollection" was that the occurrence took place in 1937 or 1938, but he apparently held this idea only as a result of thinking over, after a considerable interval, a story somewhat casually received from his local guides.

A very unusual occurrence of the polar bear is that reported (Jackson, 1939) to have taken place in October, 1938, near Lake St. John, Quebec. There seems to be no doubt of the specific identity of this animal, as attested by a photograph of its dead body that came into our hands through the kindness of Mr. Henri Gauthier, who killed the bear, and of Mr. Charles Frémont, General Superintendent of Fish and Game of the Province of Quebec. Dr. Jackson's note states that he also saw a photograph of this animal. In a letter dated January 12, 1941, Mr. Gauthier has kindly furnished a detailed account of his determined and successful hunt for this bear. While listening to his radio, he heard a regional station broadcast the news that the bear had been seen and he at once dashed away by taxi to obtain the fullest possible information from the man who had observed it! The animal, which he states was an old female with broken teeth, was shot at Savard River, about five miles from Peribonca, Lake St. John District, Quebec, on or about October 20, 1938. It appeared to be in good health, but was thin and had very little food in its stomach. The information that Dr. Jackson received through an indirect channel formed the basis of his statement that this bear was a young adult male. We have no way of reconciling this with the information supplied to us by Mr. Gauthier.

DISCUSSION

From a study of these records it should be possible to determine how frequently polar bears occur on the North Shore of the Gulf of St. Lawrence. Every effort has been made to obtain as complete and accurate a record as possible, but, due to the fact that the records are dependent upon the memories of various individuals, errors are bound to occur. It is quite possible, too, that in several instances a single bear was the source of more than one record; as, for example, the bears reported in 1939 at Duke's Island and Treble Hill Island. On the other hand, it is also likely that polar bears pass through the region unnoticed. The human population of the North Shore is so sparse that it would be possible for a polar bear to enter and leave the region unobserved. Thus, this one source of error may help to balance the other. No dates are available for several of the earliest records and undoubtedly more omissions and errors would occur in the early records than in the later ones. For these reasons it seems best to take the average from the past 21 years. We find that thirteen polar bears have been reported in the years from 1920 to 1940 inclusive. This is an average of 1.62 years per bear. If these records could have been extended farther eastward through the Strait of Belle Isle and if account could be taken of the bears that pass through unnoticed, the average would certainly be brought up to one bear a year.

When all the records of occurrence of polar bears and walruses in the northern part of the Gulf of St. Lawrence for which the month is known are considered, seasonal grouping is evident. The 17 polar bears whose month of occurrence is known were observed in the part of the year from February to July inclusive, only one record being in the latter month. The maximum number of occurrences was in April and May, for each of which four bears are recorded. Four of the five occurrences of walrus were in the period from April to July inclusive, there being one in each month of the period. One walrus was observed in December.

It is apparent that the likelihood of occurrence of polar bears and walruses in the region mentioned is greatest at the time of year when the principal arrival of drift ice from the north takes place. Since no polar bears have been seen in this region in the fall or winter, it seems that none ever takes up residence here, but that they either are killed or leave the region, probably returning to the northward as explained below. The few walruses that reach this region appear to have small chance of living here for any extended period. It seems likely that the one taken here in December was accompanying the annual southwestward migration of Harp Seals (*Phoca groenlandica* Erxleben), which is conspicuous on this coast at that season.

All the occurrences of walrus along the north shore of the Gulf of St. Lawrence recorded in this paper were to the eastward of Cape Whittle (Lat. 50° 11′ N., Long. 60° 7′ W.). Of the occurrences of polar bear recorded in this paper, only three, namely those at Thunder River, Anticosti, and Peribonca, are west of Wolf Bay, which is situated close to, and west of, Cape Whittle. With the exception, then, of the three polar bear records from west of Wolf Bay, the occurrences of both walruses and polar bears recorded here may reasonably be considered to be due to transportation of the animals away from their natural range, through the Strait of Belle Isle, and along the north shore of the Gulf of St. Lawrence by marine currents, including the southward-flowing Labrador current, intermittent westward movement of water in the Strait of Belle Isle, and a westward flow, forming part of the general counterclockwise circulation of water in the gulf, that extends along the north shore from Eskimo Islands to Cape Whittle and occasionally 50 or 60 miles farther westward.

Existence of these movements of water in the Strait of Belle Isle and the northeastern part of the Gulf of St. Lawrence is indicated by the following quotations from the 'St. Lawrence Pilot', 8th edition, 1916:

"The movement of the water in Belle Isle strait is tidal, but frequently influenced by a varying amount of 'dominant flow' in either direction for periods of time more or less protracted" (p. 25).

"On the northern shore of the gulf from Eskimo islands (Bonne Esperance) to Cape Whittle, in calms or easterly winds, the general movement of the water is westward, but in westerly winds it is very variable" (p. 26).

West of Cape Whittle a westward movement of water along the north shore, as indicated by drift of arctic ice, is much more indistinct and infrequent, though such ice sometimes, as in June, 1930, goes along that shore as far as Natashkwan Point. Off that point, which is north of the east end of Anticosti,

the current sets southeastward about two-thirds of the time. In the strait north of Anticosti the currents reverse with the tide, but the westward movement has a dominance of about 24 percent. In the area between that strait and the cross currents near Pointe des Monts no westward current has been demonstrated. We wish to substitute this brief summary of water movements in the northern part of the Gulf of St. Lawrence for the statement of Doutt (1940) that "a small portion (of the Labrador current) also enters the Straits of Belle Isle and passes westward along the north shore of the Gulf of St. Lawrence as far as Point de Montes".

It seems unlikely, moreover, that movements of polar bears, when they visit the northern part of the Gulf of St. Lawrence, can be influenced by the "perpetual cold layer" of water beneath the surface, for, according to the 'Gulf of St. Lawrence Pilot', 1st edition, 1934 (1935, p. lxvii), this cold layer lies at a considerable depth, occupying "a position between 24 and 47 fathoms (144 feet and 282 feet) in the central part of the St. Lawrence estuary south of Pointe des Monts".

The polar bear that made its unique appearance on Anticosti may have reached the east end of that island by some unusual drift of arctic ice, combined, perhaps, with swimming, and then made its way along the north shore of the island to Cap de Rabast.

The occurrence of a polar bear at Thunder River and the fact that this bear and the one whose track was seen at the mouth of the Little Mecatina River appeared to come from the vast land area to the northward and to travel directly south to the Gulf of St. Lawrence are not easily accounted for. The following suggestion is advanced.

The home of the polar bear is in arctic maritime regions. Most of those individuals that reach the Gulf of St. Lawrence appear to have a strong instinct to return to the arctic. It is not unreasonable to suppose that they are instinctively attracted to the sea. Those polar bears that land on the eastern part of the north shore of the Gulf of St. Lawrence and succeed in escaping man may persist in travelling northward or northeastward until they return, *via* Hamilton Inlet or its vicinity, to their normal range. Much of their land travel would be across comparatively barren, snow-covered country, which would presumably not incline them to turn back to the south. The bear that was met and killed by Indians between Sandwich Bay and St. Augustin was probably en route in this way to normal range.

Those polar bears that succeed in landing on the north shore of the Gulf of St. Lawrence only after they have drifted west of, say, 59° west longitude, will have before them when they start northward across country a land journey of 200 miles or more. The first 100 miles or more of this journey will be across a region that presents a reversal of normal latitudinal distributional relationships. Next to the shore, which is chilled by the proximity of cold water and ice, is a narrow belt of tundra. In the sheltered regions farther north (inland) are extensive forested tracts. Polar bears travelling northward from the gulf in this region will have the experience of going farther and farther from the sea and

also through an environment ever more southern in character, more and more unnatural to them. The instinct to travel northward, however it may be guided, would thus be placed in opposition to the instinct to seek barren country and the sea. It seems possible that in some individuals, at least, confusion may eventually result. Some may turn about and make directly south toward the Gulf of St. Lawrence, others may wander widely.

To extend this latter supposition to account even for the occurrence of the polar bear in far-off Peribonca may be straining it to excess, but no better theory to account for that occurrence is at hand.

SUMMARY

The supposed observation of walrus (*Odobenus rosmarus*) in the estuary of the Moisie River, northwest of Anticosti Island, by Jacques Cartier, in 1535, is not acceptable.

Five recent occurrences of solitary walruses on the north shore of the Gulf of St. Lawrence, between Cape Whittle and the Strait of Belle Isle, are recorded.

Reference is made to a record of three polar bears (*Thalarctos maritimus*) on the north shore of the Gulf of St. Lawrence, probably at the present Harrington Islands, in the years from 1542 to 1544.

Recent records of 24 polar bears on or near the north shore of the Gulf of St. Lawrence between L'Anse Eclair, Newfoundland Labrador, and Wolf Bay, Saguenay County, Quebec, are presented.

An occurrence of a polar bear on Anticosti Island in 1922 and an occurrence of another polar bear at Thunder River, on the north shore of the Gulf of St. Lawrence north of the west end of Anticosti, in 1919, are recorded.

The killing of a polar bear in 1938 at Peribonca, Lake St. John District, Quebec, is discussed, with presentation of data not previously published.

It is shown that walruses and polar bears probably are conveyed to points on the north shore of the Gulf of St. Lawrence east of Cape Whittle by the Labrador Current and the intermittent westward movement of water through the Strait of Belle Isle and along the shore referred to.

Theories concerning occurrence of polar bears on Anticosti Island, at Thunder River, and at Peribonca are discussed.

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BAT TAGGING IN PENNSYLVANIA TURNPIKE TUNNELS

BY CHARLES E. MOHR

While banding and tagging bats in caves in central Pennsylvania between 1932 and 1938, I heard rumors of a huge bat colony in an incompleted railroad tunnel in Blue Mountain, about 25 miles west of Carlisle, Pennsylvania. It was not until March, 1939, however, that the reports were investigated. By that time a preliminary survey was underway on a proposed superhighway through the Alleghenies, utilizing the right-of-way and unfinished tunnels of the South Penn Railroad. As roads were cut to the portals and trapped ground waters drained, the Blue Mountain tunnel and others became accessible. The tunnels, bored into the mountain ridges that hindered movement across Pennsylvania since pioneer days, were begun in 1883, but were abandoned two years later when they were only half completed.

Through the assistance of Dr. Arthur B. Cleaves, Geologist of The Pennsylvania Turnpike Commission, and Dr. Ralph W. Stone, Assistant State Geologist, I was able to visit eight tunnels, in the four easternmost ridges of the Appalachian Mountains (Mohr, 1939). These ridges from east to west are Blue, Kittatinny, and Tuscarora Mountains, and Sideling Hill. The rock strata lie in a nearly vertical position in the three easternmost tunnels. Except for flooding by trapped ground waters, these tunnels were in a fine state of preservation after nearly 60 years' disuse. To the westward the strata become more nearly horizontal, and great rock-falls had occurred in some tunnels. Rays Hill, Allegheny, Negro, Quemahoning, and Laurel Hill tunnels were described by the geologists as too dangerous to visit.

Each of the eight tunnels visited averaged 20 to 25 feet in height and 25 feet in width for most of the distance; toward the end the width was generally 18 feet. The tunnels varied in length from 1,124 to 2,369 feet (Cleaves, 1938), and offered large, cavelike areas of moderate temperature as shelter for hibernating bats.

I visited the tunnels on March 4, and March 18 and 19, 1939, and again on December 10, 1939. Descriptions of the tunnels and their bat populations follow.

BLUE MOUNTAIN: *East Tunnel.* Length, 1890 feet; condition, good; a few small rock-falls and one to two feet of water in most parts of the tunnel. On March 4, 1939, we tagged 140 bats, apparently the total population. Engi-

neering operations possibly disturbed the bats; two weeks later only 3 tagged individuals were seen whereas 35 more bats were captured. A total of 175 bats were tagged on both trips as follows: *Eptesicus f. fuscus*, 56 (38 ♀, 18 ♂), the largest population of this species encountered in the tunnels; *Pipistrellus s. subflavus*, 66 (16 ♀, 50 ♂); *Myotis l. lucifugus*, 41 (8 ♀, 33 ♂); *M. sodalis*, 12 (7 ♀, 5 ♂), the southeasternmost record for the state. No bats were found in flooded West Tunnel.

Kittatinny Mountain: *East Tunnel.* Length, 1369 feet; the portal is in a mountain valley only one-fourth mile from West Blue Mountain tunnel and is evidently the most sheltered of the entrances visited. The condition of the tunnel was excellent, with few rock-falls, and the water, before draining in November, 1937, averaged only three to four feet in depth. Due, probably, to these favorable factors, the bat population here was far larger than in any other tunnel. Nearly 3500 bats hung in many clusters of several hundred each and occupied walls throughout the inner third of the tunnel on March 18, 1939. Air temperature in this part of the tunnel was 46°F; outside, 28°.

Of the total of about 3500 bats, the following were tagged: *Pipistrellus s. subflavus*, 209 (43 ♀, 166 ♂), the largest population of this species ever reported; *Myotis sodalis*, 2 (1 ♀, 1 ♂); *M. l. lucifugus*, 143 (61 ♀, 82 ♂) of about 3200; *Eptesicus f. fuscus* were noted. One *M. subulatus leibii*, (♀), hanging 150 feet from the portal, was collected.

West Tunnel. Length, 1666 feet; in November, 1937, six to eight feet of trapped water was drained, leaving the tunnel dry. Almost all the bats, instead of hibernating on the walls as in the other tunnels, hung from the ceiling during visits on March 4 and 18, 1939. Three ceiling clusters, numbering 500, were sampled on the second visit and proved to be *M. l. lucifugus.*

Total bats, about 550. Tagged: *E. f. fuscus*, 7 (2 ♀, 5 ♂); *P. s. subflavus*, 10 (5 ♀, 5 ♂); *M. l. lucifugus*, 26 (6 ♀, 20 ♂); *M. sodalis*, 3 (3 ♀).

Tuscarora Mountain: *East Tunnel.* Length, 1962 feet; condition, poor, with many rock-falls, and, before draining, six to eight feet of trapped ground water.

Total bats, 88. Tagged: *Eptesicus f. fuscus*, 2 (1 ♀, 1 ♂), (6 others were seen); *Pipistrellus s. subflavus*, 3 (3 ♂); *Myotis l. lucifugus*, 73 (25 ♀, 48 ♂).

West Tunnel. Length, 1702; a rock-fall 1122 feet from the portal blocked off the last third of the tunnel; the rest of the tunnel was flooded to a depth of six to eight feet before draining.

Total bats, 46. Tagged: *P. s. subflavus*, 7 (7 ♀); *M. l. lucifugus*, 14 (6 ♀, 8 ♂). Not tagged: *E. f. fuscus*, 4; *M. l. lucifugus*, 6; *M. sodalis*, 1.

Sideling Hill: *East Tunnel.* Length, 1691 feet; large rock-falls had trapped ground water to a depth of 15 feet; even after draining exploration was difficult.

Total bats, 18. Tagged: *Pipistrellus s. subflavus*, 15 (4 ♀, 11 ♂); *Myotis l. lucifugus*, 1 (♂); not tagged: *Eptesicus f. fuscus*, 2.

West Tunnel. Length, 1580 feet; rock-falls numerous, water six to eight feet deep before draining.

Total bats, 74. Tagged: *P. s. subflavus* 5, (1 ♀, 4 ♂); *M. l. lucifugus*, 66 (23 ♀, 43 ♂); *M. sodalis*, 3 (2 ♀, 1 ♂).

All tagged bats were released at the tunnels where they were collected. Tags, used in preference to bird bands (Mohr, 1934), were obtained through a grant from the American Association for The Advancement of Science through the Pennsylvania Academy of Science. Attachment of the tiny aluminum "fingerling" tag to a bat's ear simplifies observation, and often permits recording of the number without disturbing the bat as would be necessary when a bird band has been placed around the tibia. On the reverse of the tag is the lettering, NOTIFY U. S. BIOL. SURV. After using ear tags for ten years I am convinced that they do not harm the bats.

In the summer of 1939, tunneling operations began, and in the space of about six months three tagged bats were reported. The only "foreign return," (recapture of a tagged individual at another locality; Griffin, 1940) reported to the U. S. Fish and Wildlife Service was no. 1063, a female *Pipistrellus*, found dead on May 6, 1939, along Chiques Creek, about one mile south of Mount Joy, Lancaster County, Pennsylvania, 50 miles due east of East Kittatinny tunnel where the bat had been tagged. Two "local returns," (recapture at the locality where the bat had been tagged) were reported to the Fish and Wildlife Service. On October 20, 1939, a man working under a pumphouse 125 feet from the portal of East Tunnel, Kittatinny Mountain, discovered that no. 1128, a male *Pipistrellus*, was clinging to his clothing. On November 17, 1939, a worker wrote that this tunnel was "alive with bats" and reported finding no. 1075, a male *Pipistrellus*, hanging 1500 feet inside the entrance.

The East Blue and East Kittatinny tunnels were revisited on December 9, 1939, and an apparent increase in the number of bats over the previous year was noted. All workmen were withdrawn from the tunnels for half an hour twice daily, when blasts were set off, yet in East Kittatinny tunnel a colony of bats, now estimated at 5,000, seemed undisturbed by tunneling operations which had approached to within 500 feet of the nearest hibernating sites. Only two dead bats were seen.

Preparations for blasting prevented a search for tagged bats at the Blue Mountain tunnel, but in East Kittatinny tunnel 10 tagged *Pipistrellus* (1 ♀, 9 ♂) and 2 *Myotis l. lucifugus* (1 ♀, 1 ♂) were located in a hurried inspection. The tagged individuals were scattered widely through the total population which occupied a slightly more restricted area than during the previous winter. The tagged bats and 140 additional ones were taken to Conodoguinet Cave (Stone, 1932) which lies directly beneath the superhighway at Carlisle, 25 miles east of the first tunnel. This 300-foot-long cave has scarcely any side passages and I have never seen more than 20 bats hibernating in it. Here, on December 10, 1938, we left 108 *Pipistrellus* (34 ♀, 74 ♂) and 44 *M. l. lucifugus* (15 ♀, 29 ♂). They were tagged and released at the entrance of the cave, but many of the bats circled about for several minutes before entering. Perhaps a third of the bats disappeared outside, some flying directly westward toward the abandoned tunnel from which they had been taken. The air temperature remained above 40°F. on the night of December 10, but dropped to 20°F. on the following day.

Five weeks later, on January 13, 1940, we revisited Conodoguinet Cave and found 32 tagged bats, 20 live and 12 dead ones. This amounted to 20 percent

of the bats released there. The dead bats evidently had been knocked from their perches by visitors from nearby Carlisle and had been trampled into the mud. Since those bats which were out of reach or not easily seen appeared to have accepted their new environment, we thought that if a more remote cave were used a large number of the endangered bats could be transferred to it from the tunnels. We chose Aitkin Cave, located 20 miles north of Lewistown, in Mifflin County, Pennsylvania, and 80 miles north of the tunnels, because few persons know its location, and because it is quite extensive and already harbors a colony of about 5,000 bats (Mohr, 1932).

Accordingly, we went on to East Kittatinny tunnel from Conodoguinet Cave, and in three hours gathered about 2500 bats, all that we could reach easily with our collecting nets. Among them were 11 more tagged bats: 10 *Myotis l. lucifugus* (4 ♀, 6 ♂) and a single *Pipistrellus* (♀). Sleet and driving rain hampered the transfer, and after tagging 119 bats and identifying 381 others, we were forced to abandon the project, releasing all of the bats in Aitkin Cave on January 13, 1940. These tagged bats included 19 more *Pipistrellus* (8 ♀, 11 ♂), 91 *Myotis l. lucifugus* (47 ♀, 44 ♂), and 9 *M. sodalis* (6 ♀, 3 ♂). The other 381 bats, untagged but examined, were: *M. l. lucifugus*, 368 (185 ♀, 183 ♂); *P. s. subflavus*, 11 (2 ♀, 9 ♂); *M. sodalis*, 2 (1 ♀, 1 ♂). The higher proportion of females than usual in these figures indicates, I believe, that the females were more active than the males and consequently a greater proportion of them climbed to the top of containers and so were the first to be withdrawn.

In the following winters of 1940–41 and 1941–42, frequent trips to Aitkin and other central Pennsylvania caves failed to disclose a single tagged bat or any perceptible increase in the normal populations. This failure of the transferred bats to return to their foster hibernating quarters was not totally unexpected because homing experiments which I had carried on in southeastern Pennsylvania (Mohr, 1933 and 1934) demonstrated that bats that have been removed from their summer roosts will return from distances ranging from 1.2 to 80 miles. An attempt to transplant a colony of more than 200 *M. l. lucifugus* from one deserted house to another one, equally dilapidated to my way of thinking, had proved a total failure. The bats returned 12 miles overnight, a single injured specimen being left behind.

Since so few of the transplanted tunnel-bats could be tagged it is unlikely that any trace of them will ever be found. A continuing search for them is planned, however, on the chance that some of them may have found sufficient shelter to enable them to survive the first winter. My recovery of a *Myotis l. lucifugus*, no. 255, on July 21, 1939, at its summer roost, seven years after I had tagged it as an adult on July 5, 1932, offers some encouragement in the search for tagged or banded bats over considerable periods of time.

SUMMARY AND CONCLUSIONS

1. Seven bat populations, varying widely in makeup, were found in unfinished railroad tunnels, prior to their development into the Pennsylvania Turnpike, in the four eastern ridges of the Appalachian mountains in southcentral Pennsylvania in the winters of 1938–39 and 1939–40.

2. The tunnels, abandoned since 1883, were in varying states of preservation. East Tunnel, Kittatinny Mountain, the longest and one of the two best preserved tunnels, and the one whose entrance was the most sheltered, harbored a bat population ten times as large as that of any other tunnel and is equalled only in one other Pennsylvania cave. Bats were scarcest in tunnels whose trapped ground waters had come within 10 to 15 feet of the roof, or closer, and tunnels in which numerous bad cave-ins indicated unstable conditions.

3. In November, 1939, a large bat colony went into hibernation while tunneling operations were in progress and was exposed to nearby blasting without apparent harm or evident disturbance.

4. After an experimental transfer of 162 tagged bats to Conodoguinet Cave, 2500 bats were removed to Aitkin Cave, 80 miles away, in the winter of 1939–40. About 5 percent were tagged. Search in the following two winters failed to reveal any tunnel bats although many bats were reported flying through the completed tunnels in the fall of 1940. This apparent return to the tunnels compares with homing behavior observed elsewhere in Pennsylvania.

5. A record, two-year *Pipistrellus* population of 366 individuals (95 ♀, 271 ♂) in one tunnel is reported, and disproportionate sex ratios of *Pipistrellus*, *Myotis l. lucifugus*, and *Eptesicus* are noted.

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FOOD HABITS OF THE BADGER IN IOWA

By Edwin Snead and George O. Hendrickson

The common badger, *Taxidea taxus taxus* (Schreber), increased from a status of almost virtual extinction shortly after the turn of this century to its present common to rare occurrence throughout the entire state (Scott, 1937). This increase of the animal has led to renewed interest in its economic relations, especially with regard to its food habits.

The present investigation was carried on during a two-year period in two widely separated areas: (1) Lyon County in the northwestern corner of the state and (2) Boone County, plus the adjoining southern fringe of Hamilton County, in central Iowa. The data from Lyon County collected in the summer of 1939, served for comparison with the major data gathered in central Iowa where field observations were made as regularly as was practical, March 15-Dec. 15, 1940.

In Boone County a belt of morainic hills extends east and west across the northern portion, overlapping into Hamilton County to the north. One area investigated in the northern morainic hills extends east and west across the northern portion, overlapping into Hamilton County to the north. One area investigated in the northern morainic belt lies in parts of both counties and is characterized by numerous interlocking sandy glacial hills and ridges interspersed with small marshes and sloughs. Two other areas studied in the western part of Boone County in the Beaver Creek drainage are typified by gently rolling prairie traversed by numerous scarcely incised narrow streams. Because of the difficulty encountered in tilling the morainic hills, marshy stretches, and sloping stream valleys, all three areas have numerous pastures and hayfields, which furnish habitat for a modified prairie flora and fauna.

The areas in Lyon County, though resembling somewhat the adjacent dry western plains, like the Boone County areas were essentially prairie originally.

In determining the relative quantities of different kinds of foods taken, the frequency of occurrence was the method used in the analysis of 188 droppings obtained in the Boone County area and 51 from Lyon County. The sparse population of badgers and the animal's somewhat secretive habits of defecation added to the difficulties in finding the scats. The droppings were found commonly at the bottoms of the numerous shallow excavations around groups of dens or at the bottoms of scars from older holes that had filled in. Often the droppings were completely buried in the mounds of earth at the entrances to burrows or were hidden an inch or so beneath the surface of a nearby bare spot in the vegetative cover. It was obvious that the burial of scats was frequently deliberate. Less frequently the droppings were covered only by tufts of sod or were completely exposed and conspicuously placed on den mounds or on the surface of the ground close by. Certain individuals apparently never concealed the droppings whereas others probably nearly always buried them or deposited them in surface depressions.

Difficulty arose in the separation of badger droppings composed largely of

insects from those of the striped skunks (*Mephitis hudsonica* and *M. mesomelas avia*), especially where both badgers and skunks were on the same ranges, sometimes, at least temporarily, occupying dens within a few feet of each other. Scats containing largely insects were classified as those of the badger when they had badger hair inclusions, and when the matrix and size of insect fragments were characteristic of previously known badger scats (Plate 1, right).

In the field, data were frequently available on the methods used by badgers in securing their food items. The nature of holes dug in obtaining prey, the cleaning out or re-excavation by the animal of older holes, and tracks at the entrances of holes or in the earth removed from shallower diggings furnished clues as to

PLATE 1

LEFT: Permanent pastures with typical badger diggings. RIGHT: Samples of badger scats.

what species were taken, how they were secured, and the movements of the animal in seeking food.

The data are treated in three different periods based on shifts in the quantities and types of the more important foods consumed. These periods, summarized in Table 1 and 2 for central Iowa, also correspond roughly to the three seasons of the year (spring, summer, autumn) involved in the study. The findings for northwestern Iowa in the summer period appear in Tables 3 and 4. Usually remains of several species were found in a single scat and some were represented by a greater amount of undigested portions than others. Most of the items (various small mammals) were probably digested at about the same rate and in

general the comparison of the undigested portions of them is considered a reasonably accurate means for establishing their relative values as foods.

SPRING PERIOD, MARCH 15–JUNE 1

Ground squirrels (*Citellus* spp.), appearing in 75.61 percent of the scats, were the staple food of the period. The striped ground squirrel (*Citellus t. tridecemlineatus*), in 58.54 percent of the droppings, was the most important single species consumed. Therefore, the methods and activities of the badger in preying on this rodent warrant first attention.

Throughout this period there was much digging by badgers. On the bases of location, depth, exposed portions of nesting material and winter grain stores, many of these excavations were known to represent attempts to secure striped ground squirrels. The majority of their burrows were located on crests of sandy hills or slopes of well-drained, grazed, permanent pasture lands, apparently situations preferred by the striped ground squirrel (Plate 1, left). Probably many of these badger excavations did not represent successful acts of predation because the portions of the burrow enlarged by the carnivore were sometimes shallow and the burrows of the ground squirrels were seen to continue undisturbed. Also, the occurrence of more than one entrance to many of the rodent burrows, which were disturbed sometimes for varying lengths, presented facilities for the rodents' escape.

There were intervals of one to several weeks with little evidence of fresh badger digging except at holes previously dug, and usually at groups of such. Ground squirrels continued to use sections of their tunnels branching, or continuing, from the portion that had been enlarged by badgers, and in other instances it was evident that the passages had been formed by the rodents digging into the walls of temporarily unused badger excavations. Examples of the latter type often had their entrances just below the sod line, presumably where the digging was easier than at the surface. In some cases, ground squirrel burrows were sunk in mounds of soft earth piled at the entrances of badger excavations. In several instances striped ground squirrels were seen to use badger holes within a day or two after the badger excavations were made or re-worked. Either the rodents of the last example were those that had escaped a predation attempt and still were using the remnants of their burrows or they were new residents that had moved in from the surrounding portions of the range. The constancy with which badgers revisited the previously formed holes, often further excavating portions of them, would indicate that much of this activity is attributable to quest for food species such as the striped ground squirrel.

The striped ground squirrel was prominent in the predator's food caches. In one locality, visited in mid-April when badger activity was much in evidence, the bodies of five relatively fresh striped ground squirrels were unearthed from various shallow diggings and mounds of earth at the entrances to badger excavations. In this same locality a month later, five caches of striped ground squirrels, or portions of them, were found concealed in shallow holes, 6 to 10 inches deep, located among or close to groups of badger holes.

Remains of the Franklin ground squirrel (*C. franklini*) appeared in 21.95 percent of the droppings. Although Franklin ground squirrels were infrequently seen and with due consideration given their more secretive habits, their numbers were known to be much less than those of the striped ground squirrel.

Several species of mice, mostly white-footed mice (*Peromyscus*) and meadow mice (*Microtus*), appeared in 58.54 percent of the scats. As the season advanced, the number of occurrences of mice decreased in about the same proportion as the number of ground squirrel representations increased. While the frequency of

TABLE 1.—*Food groups, March 15–Dec. 15, 1940, central Iowa*

FOOD GROUPS	FREQUENCY OF OCCURRENCE PERCENTAGES BY PERIODS			
	First (41 scats)	Second (103 scats)	Third (44 scats)	Total[1] (188 scats)
Ground squirrels	75.61	83.49	52.27	67.67
Mice	58.54	24.27	56.82	45.55
Cottontail	29.27	20.39	31.82	25.49
Birds	14.63	4.76	13.64	9.97
Snakes (trace)	—	.97	2.27	1.03
Insects	17.07	43.69	11.36	27.10
Plant remains (mostly traces)	7.31	9.71	11.36	10.47

[1] Based on average monthly percentages.

TABLE 2.—*Mammal foods, March 15–Dec. 15, 1940, central Iowa*

FOOD GROUPS	FREQUENCY OF OCCURRENCE PERCENTAGES BY PERIODS			
	First (41 scats)	Second (103 scats)	Third (44 scats)	Total[1] (188 scats)
Thirteen-striped ground squirrel	58.54	72.81	47.73	56.12
Franklin ground squirrel	21.95	15.53	20.45	21.07
Shaw pocket gopher	2.44	1.94	—	1.06
Harvest mouse	7.32	3.88	9.09	7.54
White-footed mice	39.03	14.56	43.18	32.75
Meadow mice	24.39	9.71	29.54	21.96
Undetermined Cricetidae	2.44	3.88	9.09	6.64
House mouse	4.88	—	6.82	5.40
Mearns cottontail	29.27	20.39	31.82	25.49
Misc. and undetermined mammals	—	(0.97)	6.82	1.82

[1] Based on average monthly percentages.

occurrence of mice as a group was the same as that for the striped ground squirrel, the inequality in size of the mammals in the two groups, together with the fact that mice inclusions were usually representative of only one or two individuals, must be considered in estimating the relative food utility. The importance of mice, however, as an early and mid-spring food is not to be minimized.

Remains of Mearns cottontails (*Sylvilagus floridanus mearnsii*) appeared in 29.27 percent of the scats. The consumption of adult rabbits in the earlier part of the period shifted to the utilization of juvenile animals as the season

advanced. The substantial number of adult cottontails obtained (31.2 percent for April) represented largely carrion, either carcasses chanced upon or fragments of such killed or acquired by other predators. Probably a few of the cottontails were surprised and killed while at their surface forms. But there is also reason to believe that at least some of them were made available through cottontails' use of entrances to badger burrows and shallower excavations as forms, or by the rabbits' use of the burrows proper, presumably for shelter.

In a 38-acre hilly, bluegrass pasture, for instance, several cottontails were repeatedly seen to use as sites of forms the old, shallow badger excavations and hollows of caved in badger burrows. The forms were well towards the middle of the pasture, which was practically sheared of surface vegetation tall enough to offer concealment for a cottontail. Immediately around the utilized cavities the grass was taller than elsewhere, apparently a result of such areas being avoided by livestock. The more recent burrows, perhaps of the previous year or two, were surrounded by old stems of lesser ragweed (*Ambrosia artemisiifolia*) and other annual weeds that sprang up following disturbance of the sod and remained through the winter. In other places, cottontails were flushed from forms in the entrances of newly dug badger burrows. The cottontails by sitting erect in the various forms were able to see above the ground level. In these examples two considerations seem evident. One is that the habitability for cottontails of overgrazed, badger-inhabited fields was markedly increased through the provision of cover in the form of badger holes and depressions, and indirectly by the relatively taller vegetation following the disturbance of the plant succession. The other consideration is that rabbits making use of such cover would be more vulnerable to attacks by badgers occupying the range or returning to it. The increased vulnerability would result from the predator's habit of revisiting former excavations and from the location of the forms exposing the cottontails, cornered or chased down the holes proper, to more dangers from attacks by badgers.

More convincing data on cottontail availability were to be had in instances of cottontails making use of the burrows proper. Evidence was usually present only in the form of tracks left after rains. But here again, in consideration of the badger's habit of re-entering formerly dug holes, it is not such a far step to assume that cottontails found therein would fall more easily as prey.

With respect to nestling cottontails and the older young, inferences of their importance as a food of the badger were drawn mainly from the fecal determinations. Juvenile cottontails appeared first in the droppings in May to compose three of the four cottontail representations for that month, total occurrence 8.57 percent. On the basis of numbers and degree of development of incisors present, the numbers of nestlings represented in each of the three droppings respectively were two, three, and four. Early in May, a young cottontail, probably just out of the nest, was noticed sitting at the entrance to one of a group of badger holes. In a moment it turned and ran down one of the burrows. This particular set of holes was situated near the center of a hilly, overgrazed, 15-

acre bluegrass pasture and no evidence of a cottontail nest could be located by intensively searching the surrounding area within a 50-yard radius and by covering the remainder of the pasture in a more casual manner. The locality was occupied by badgers about three or four weeks previously and one week following the incident. In a larger pasture, three nests of young cottontails were found in May within 100 yards of several badger excavations that adult cottontails were seen entering and leaving.

Although no jack rabbit (*Lepus townsendii campanius*) remains were identified from the feces for the period, there was occasionally field evidence to indicate a limited use of this mammal as food. Although it is not characteristic for badgers to leave many remnants of food items around the dens, occasionally bits of pelage and the less palatable parts of larger prey, such as the hind feet of jack rabbits and cottontails, were found near the carnivore's holes.

Shaw pocket gopher (*Geomys bursarius*) was represented in only one scat, and early in the period.

Bird remains were scanty and of a total of six occurrences (14.63 percent) all were represented only by traces or small quantities of feathers. Poultry, represented in three scats by traces of feather stubs, leg scales, and feet, was probably carrion when eaten. One dropping contained a few feathers from a small unidentified bird, and two more contained the downy feathers of unidentified nestling birds. Ground-nesting birds were not numerous, partly because of lack of cover in the closely grazed pastures.

Among the other less important foods were insects in 17.07 percent of the droppings. Represented only by a few individuals when present, these consisted mostly of adult carrot beetles (*Ligyrus gibbosus*), bumblebees (*Bremus*) and a few undetermined beetle larvae.

Plant remains were present as traces in more than one-half of the droppings, but most of these remains obviously represented seeds and other parts of plants from the stomachs and cheek pouches of rodents, or fragments of plants. In three droppings (7.31 percent) small wads of grass stems and leaves appeared as though they had been eaten intentionally.

Practically all of the droppings contained a considerable quantity of a fine grained residue, which formed a matrix around the identifiable inclusions. Mention should be made also of the varying quantities of sand commonly present, of which the particles were sometimes 5 mm or more in diameter and probably consumed incidentally as were most of the plant remains.

THE SUMMER PERIOD, JUNE 1–OCT. 1

Central Iowa.—During this period ground squirrels and insects increased and the other food groups decreased in importance in varying degrees.

The two species of ground squirrels were represented in 83.49 percent of the 103 droppings for the period. This pronounced increase was due to a higher percentage of striped ground squirrels taken, since the percentage of Franklin ground squirrels consumed underwent a decrease.

The relatively high figure for the striped species (72.81 percent) was in turn most probably due to the increased availability of nestling or older juveniles, chiefly during June and July. A record of the number and ontogenetic development of the teeth in the scats offered a fairly accurate index to the age of the rodents consumed, especially as teeth were nearly always among the remains. In general, corresponding with the production of young striped ground squirrels, the remains of the young animals in scats occurred in increasing numbers from May to June, and continued to be evident in relatively large percentages in July as long as a distinction between adults and subadults could be made. Of the 70 droppings collected for June and July, the remains of striped ground squirrels identifiable as adults appeared in 51 percent, those identifiable as young or immature appeared in 59 percent, and the appearance of all ages was 87 percent. As many as one adult and five young ground squirrels were represented at least in part in a single scat, indicating that possibly a family group had been taken. An abundance of partly grown striped ground squirrels during June and July was discernible in numerous field observations. The large litters of the striped ground squirrel, 5 to 13 young (Howell, 1938), partly explain the rapid increase in the numbers of this rodent prey.

By mid-July the appearances of new badger excavations became relatively infrequent and many of them were shallow as though insects were being sought, but digging activity continued at the previously formed holes. The decline in the appearance of new holes was accompanied by an interval of dry weather when the surface of the ground was dry and hard. During the dry interval, the droppings were buried less frequently, often lying exposed with only a tuft or two of grass raked over them. For August and September, the situation remained about the same except during the last week in August and the first week in September when there was a temporary increase in new holes dug following intermittent rains.

Other mammals were taken in proportionately smaller numbers than in the previous period, possibly largely as a result of the increased population of the striped ground squirrel, which was represented in 15.53 percent of the scats; about one-half were young animals.

Remains of cottontails appeared in 20.39 percent of the droppings and were mostly represented by nestling or partially grown animals. Consistent with the trend towards consumption of young cottontails towards the close of the previous period, three times as many scats contained remains of nestling or older juvenile rabbits as contained representations of adults.

Observations of tracks after rains indicated that adult cottontails continued to use the badger holes. One startled, half-grown cottontail was seen to take refuge in one of a group of badger holes.

Mice, considered as a group, appeared in 24.27 percent of the droppings; the frequency was less than one-half that for the previous period. The two important genera were taken in about the same proportion, *Peromyscus* occurring in 14.56 percent and *Microtus* in 9.71 percent of the samples.

The remains of two Shaw pocket gophers (1.94 percent), both young, were

present in scats from the early part of the period. At one set of burrows made by pocket gophers 19 holes of various depths were sunk by badgers.

A trace of hair of southern woodchuck (*Marmota monax monax*) was found in one dropping. As possible badger food the woodchuck is of slight importance because it is largely absent from the prairie ranges.

Remains of birds were also of minor importance. Five traces of birds or their eggs, in 4.76 percent of the total, appeared in the droppings for June and July, but none was recorded in the succeeding two months. Of the five traces, two were small amounts of undetermined egg shell, two represented undetermined small birds, and one represented a nestling bird.

The only cold-blooded vertebrate representation was a small amount of scales and bones identified as a garter snake (*Thamnophis*).

In contrast to the decreases in consumption of vertebrate foods, exclusive of the striped ground squirrel, was an increase in the amount of insects taken. In general, the frequency of their appearances increased rapidly in June, reached the maximum in August, and declined in September to form altogether a 43.69 percent occurrence for the period. Bumblebees, including many larval and immature forms, were found in 28.11 percent of the scats and were taken together with cocoons and waxy portions of the nest in greatest numbers in July. Seldom were any cocoons or honey-bearing portions left uneaten in the numerous observed rifled bumblebee nests, but often there were one or two dead adult bees that apparently had been rejected.

May beetles (*Phyllophaga*) both as adults and the white grubs were the next most important insects taken. They occurred in 11.65 percent of the samples distributed throughout the period. Other insects of varying importance especially towards the last of the period were carrot beetles and a large ground beetle (*Harpalus caliginosus*).

Plant remains, especially quantities of grass, appeared mostly as traces in more than one-half of the droppings, but in only 9.71 percent were they regarded as having been taken intentionally. Besides small quantities of grass the pertinent plant remains included varying amounts of corn which appeared in four droppings in August and early in September. The corn, very slightly digested, was apparently taken before the kernels became firm.

Quantities of sand and unidentifiable debris appeared as for the previous period. To these summer findings in central Iowa may be added those of Errington (1937) who in 37 badger droppings, gathered in June and July in the lake and marsh region near Ruthven in northwestern Iowa, found by volume percentages: ground squirrel remains 53; mice, 30; hymenopterous and coleopterous insects, 9; grebe, teal, and pheasant feathers together with eggshell and other miscellaneous plant and animal items, the remainder.

Northwestern Iowa—The analyses of droppings from Lyon County represent the food habits for the period, June 1–Sept. 1, 1939. The data (Tables 3 and 4), are presented without discussion to support the trends of the central Iowa summer data which they closely resemble.

TABLE 3.—*Food groups, June 1–Sept. 1, 1939, Lyon County*

FOOD GROUPS	FREQUENCY OF OCCURRENCE PERCENTAGES (51 SCATS)
Ground squirrels	82.35
Mice	41.18
Cottontail	13.73
Birds	5.88
Insects	58.82
Plant remains (traces)	13.72

TABLE 4.—*Mammal foods, June 1–Sept. 1, 1939, Lyon County*

MAMMALS	FREQUENCY OF OCCURRENCE PERCENTAGES (51 SCATS)
Thirteen-striped ground squirrel	72.55
Franklin ground squirrel	17.65
Shaw pocket gopher	1.96
Harvest mouse	3.92
White-footed mice	23.53
Meadow mice	9.80
Undetermined Cricetidae	13.72
Mearns cottontail	13.72

THE AUTUMN PERIOD, OCT. 1–DEC. 15

The percentages of striped ground squirrel appearances were roughly 53, 45, and 40, respectively, for October, November, and December, while the frequency occurrence for the period was 47.73 percent. Probably among the causes for this apparent downward trend with respect to the consumption of striped ground squirrels was a decreased availability of these rodents, especially as the season advanced. Striped ground squirrels, known to hibernate early, were noticeably less by Oct. 15 and none was seen after a cold wave early in November. The freezing of the ground undoubtedly was an important factor involved in reducing the take of ground squirrels towards the later part of the period, although a number of new holes were made after the freezing commenced. Within a day or two after a severe cold wave accompanied by snow began on November 11, four holes had been sunk in one pasture, apparently in attempts to secure hibernating striped ground squirrels. At odd times almost until the last of this period, scattered new holes made in ground containing varying amounts of frost continued to appear. The digging in previously formed holes continued in somewhat lessened amounts throughout the later part of the period and into the winter season when the surface of the ground was frozen solid. Activity of this type was confined almost solely to the den groups in more or less sandy soil, the least affected by freezing because of low moisture content. There, badgers had access to the ground below the frost line and any ground squirrel having the entrance to its hibernation chamber located in the wall of

one of the subterranean branches of a previously dug badger hole would be potential prey.

Further evidence towards the opinion that considerable use as prey was made of striped ground squirrels taking abode in connection with previously formed badger excavations was afforded through the examination of the subterranean portions of several badger excavations that had been exposed through caving in by livestock and erosion by weathering. Two of these excavations, of considerable size and giving evidence of probably having been used intermittently by badgers and ground squirrels over a number of years, were found to consist of a central chamber with one or more openings and several random side tunnels of varying lengths. Branching from the central chamber in one of these examples were one opening to the surface, four blind side tunnels, and three relatively short pockets. The four side chambers, which had at one time led to the surface and still pointed to scars of openings on the ground surface, had since been filled in by erosion and sandy earth removed from other portions of the den. One of them had been reopened by a striped ground squirrel burrow. Of the three shorter pockets, one led directly down in the middle of the chamber where possibly something had been buried and the other two had striped ground squirrel burrows continuing from their extremities.

The percentage occurrence of Franklin ground squirrel was 20.45, very close to the percentage for the spring period.

Characteristic of this period was the increased consumption of mice. Here again the 56.82 percent occurrence compares with the figure for the earliest period. And while the percentages of white-footed mice and meadow mice were also similar, 43.18 and 29.54, respectively, a larger percentage of young animals was represented. All species considered, the remains of young mice appeared a few more times than did remains of those that appeared to be adults. Of small importance were the remains of the harvest mouse in 9.09 percent and house mouse in 6.82 percent of the samples.

The shift back to a more diversified diet was indicated further by the presence of cottontail remains in 31.82 percent of the droppings. One of these droppings deposited at the first of the period included teeth and bones from a partly grown rabbit. Otherwise, the remains that gave age-telling evidence were all considered to be from mature cottontails.

Observations, as in the other periods, of cottontails making use of badger excavations as form sites and escape cover, were fairly common. Snow during the period increased opportunities for such records. Two closely grazed pastures containing groups of badger dens and scattered excavations were examined in mid-November, four days after snowfall. In both localities practically all of the deeper holes and some of the shallow excavations had several cottontail tracks leading to and from them. Snow at the entrances to some of them had been packed down by cottontails as though the entrances or holes proper had been utilized quite regularly. The presence of badger tracks leading to and from most of the deeper holes in one pasture added strength to the assumption that badger excavations were of importance in making cottontails more available.

Miscellaneous materials were traces of unidentified mammals in two droppings and a large quantity of bristles from a domestic pig (*Sus*) in another. The latter probably represented carrion or slaughter offal.

Bird remains, in small quantities or traces in 13.64 percent of the scats were probably mostly representative of poultry carrion.

There was some evidence that badgers had eaten bony portions of prey animals that seemingly had been discarded by other predators. A scarcity of food fragments around active badger dens further signified a high degree of utilization of prey. During the latter part of this period, when there was reason to believe that badgers were somewhat hard-pressed for food, more types of carrion were probably acceptable.

The only cold-blooded vertebrate representation was a few remains of a garter snake taken in October. The partly eaten body of a tiger salamander (*Ambystoma t. tigrinum*), which had apparently been removed from its place of hibernation within a badger burrow, was found near the entrance.

Small amounts of insect remains appeared in 11.36 percent of the scats. They represented a few grasshoppers and crickets (Orthoptera) which were probably of negligible importance.

Plants were likewise among the foods more rarely taken. Three droppings contained small amounts of various grass leaves and stems; one each contained a small milkweed pod (Asclepiadaceae), fruits of black nightshade (*Solanum nigrum*), and hulls of oats. The last two items were present in considerable quantities and possibly are further indications of food scarcity during the latter part of the period.

Sand, debris from stomachs of mammals, and amorphous residue were present in varying amounts as in the previous periods.

SUMMARY

The kinds and quantities of foods taken by the badger in Iowa were determined by the frequency of occurrence percentages of food remains in 51 scats for the summer period, 1939, in northwestern Iowa and in 188 scats for the period from March 15 to Dec. 15, 1940, in central Iowa. Ground squirrels (67.67 percent), mice (45.55 percent), cottontail (25.49 percent) and insects (27.10 percent) were major food items in central Iowa. Of less importance were birds, pocket gophers, and snakes. Traces of plant material were found in the scats. The most frequent prey, the striped ground squirrel, was taken in greatest numbers in summer when the least number of mice were consumed. Insects, especially various ages of bumblebees, May beetles, and larger ground beetles were eaten in greatly increased proportions during the summer months. Data for northwestern Iowa were much like those for summer in central Iowa. Badger food caches were observed to a limited extent particularly in the spring. Besides acquiring food on the ground surface and digging prey from burrows, the badger consumed many striped ground squirrels and cottontails made more readily available by intermittent co-use of the various types of previously formed badger excavations by both predator and prey.

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NOTES ON THE MAMMALS OF MOUNT DESERT ISLAND, MAINE

BY RICHARD H. MANVILLE

Mount Desert Island, Hancock County, Maine, is situated in the Gulf of Maine about 20 miles northeast of Penobscot Bay. It is nearly circular in outline, with an area of approximately 100 square miles. The channel separating it from the mainland is so narrow as hardly to constitute a barrier to mammal dispersal, especially as it frequently freezes over. A range of granitic mountains, the highest (Cadillac Mountain) rising to 1,532 feet, extends across the southern part of the island. Most of this mountainous part, with its many lakes, is included in Acadia National Park, and as such is a sanctuary for wildlife. The entire island has been subjected to glaciation and many barren, rocky summits persist; the soil, for the most part, is a brown, stony, glacial till. The rockbound coastline presents everywhere a rugged appearance. Climatic conditions at Bar Harbor, as compiled by Mindling (1930), are indicated by the following figures: mean annual precipitation, 47.89 in.; average annual snowfall, 74.9 in.; mean annual temperature, 44.2°F.; average maximum temperature, summer, 74°, winter, 32.5°; average minimum temperature, summer, 52.6°, winter, 15°; highest temperature on record, 96°; lowest temperature on record, −21°; length of growing season, 149 days. Proximity to the Labrador Current, plentiful rainfall and frequent fogs, and a variety of environmental conditions make for a peculiar combination of northern and southern kinds of plants and animals. Moore (1921) mentions the island's former connection with the mainland, and the northward migration of many forms of life after the recession of the glaciers, as possible causes of the unusual flora and fauna.

The forests are essentially northern in character, belonging to the spruce-fir and northern hardwood types. Spruces are dominant, the red spruce in the hinterland and the white spruce along the waterfront. Mingled with these, or in small pure stands, are balsam fir, white cedar, white and red pines, hemlock, and such hardwoods as white, grey, and yellow birchs, red and sugar maples, aspen, red oak, and beech. Pitch pine occurs in isolated pure stands, associated with huckleberry (*Gaylussacia baccata*), bearberry (*Arctostaphylos Uva-ursi*), and in some places *Corema Conradii* and *Hudsonia ericoides*. There are bogs with black spruce, Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamae-*

daphne calyculata), as well as salt marshes. The occurrence of such southern plants as mountain laurel (*Kalmia latifolia*), mountain holly (*Nemopanthus mucronata*), and scrub oak (*Quercus ilicifolia*) on the same island with the baked-apple berry (*Rubus Chamæmorus*), crowberry (*Empetrum nigrum*), and Arctic cinquefoil (*Potentilla tridentata*) of the north, emphasizes the peculiar situation.

Pope (1921) made an ardent plea for the gathering of data on mammals in the state of Maine. Mount Desert Island, with its several biological stations, would seem to have been a natural center for such research, yet few papers concerning the mammals of the island have appeared. Bailey (1925), in an unpublished manuscript, lists thirty species. Twitchell and Crockett (1925) merely enumerate four species (*Peromyscus*, *Clethrionomys*, *Glaucomys*, and *Tamiasciurus*). Johnson (1927) reports experimental studies on *Peromyscus*, *Clethrionomys*, and *Microtus*. Stupka (1932–35) has recorded many observations on the island mammals in a mimeographed bulletin. Branin (1936, a and b) in two papers has discussed *Zapus* and *Napaeozapus*; and in another paper (1939) gives an annotated list of twelve kinds of small mammals trapped on the Island. Excavations of old Indian sites along the coast of Maine have yielded remains of earlier mammals. In the Mount Desert Island region, Wyman (1868) has unearthed bones of wolf, beaver, deer, and elk; and Moorehead (1922) reports the gray seal (*Halichoerus*), the Indian dog, and sea mink, as well as large numbers of raccoon, lynx, wolf, muskrat, and deer.

During the summers of 1937–39 the writer was employed as a ranger-naturalist in Acadia National Park and collected certain of the mammals of the island. Specimens of many of the species mentioned herein are preserved in the collections of the Acadia National Park (ANP) at Bar Harbor, and of the Museum of Zoology at the University of Michigan (UMMZ). Reports were gathered from various local residents acquainted with the mammalian fauna of the island. This paper summarizes these scattered data and, it is hoped, presents a more complete picture of the mammal life on the island. Forty-four species are herein discussed.

Grateful acknowledgment is made to my fellow workers for specimens and data contributed, in particular to Louis R. Fowler and Ora Y. Thompson, rangers; Vernon Lunt, C.C.C. foreman; and Lyle E. Smith, game warden. I am especially indebted to Arthur Stupka, park naturalist of the Great Smoky Mountains National Park, who has generously turned over to me data collected by him during three years in Acadia National Park. Dr. W. H. Burt has kindly read the manuscript.

LIST OF SPECIES

Parascalops breweri Bachman. Brewer's mole.—No specimens of the hairy-tailed mole have been seen by the writer, but they are reported by local residents. Bailey (1925) writes that they "undoubtedly occur in fields and gardens upon the island. . . . Many mole hills were seen that were evidently made by this species."

Condylura cristata Linnaeus. Star-nosed mole.—Known from two specimens, one obtained the summer of 1934 by Vernon Lunt at the south end of the Tarn, the other on June

2, 1936, by Maurice Sullivan at the Brown Mountain Gate House. Hills and runways commonly seen in damp ground are doubtless the work of this mole. Specimens examined: ANP, 2.

Sorex cinereus cinereus Kerr. Masked shrew.—Apparently distributed over most of the island, but usually taken in moist lowland areas. Jackson (1928) lists two specimens from Southwest Harbor examined by him. Specimens examined: ANP, 17; UMMZ, 1.

Sorex palustris albibarbis Cope. Water shrew.—Two specimens were collected on June 15 and 29, 1935, by Louis R. Fowler at the south end of Jordan Pond. They were taken in a swamp under the roots of white cedar. Specimens examined: ANP, 2.

Microsorex hoyi thompsoni Baird. Pigmy shrew.—One specimen was taken April 15, 1935, by Vernon Lunt in heavy spruce and pine woods at the west side of Eagle Lake. Specimen examined: ANP, 1.

Blarina brevicauda talpoides Gapper. Short-tailed shrew.—Common and well distributed over the island. It has been collected from sea level to the summit of Cadillac Mountain, in marshes, meadows, hardwood and coniferous forests. Specimens examined: ANP, 67; UMMZ, 2.

Myotis lucifugus lucifugus Le Conte. Little brown bat.—These bats are commonly seen at dusk, especially in the late summer. Twelve were observed under the loose bark of a birch tree on July 25, 1935, by members of a C.C.C. crew, and five of them collected. At least 4 of the 12 were said to be immature. Specimens taken after September 9, 1939, had thick layers of subcutaneous fat. Specimens examined: ANP, 6; UMMZ, 1.

Myotis subulatus leibii Audubon and Bachman. Leib little brown bat.—One specimen, taken on September 11, 1939, by Louis R. Fowler at Otter Point was identified by Dr. Glover M. Allen as this species. Specimen examined: UMMZ, 1.

Lasionycteris noctivagans Le Conte. Silver-haired bat.—No specimens of this bat have been seen, but it probably occurs in migration. Merriam (1887) mentions several specimens collected about October 1, 1885, by Thomas Milan, keeper of the lighthouse on Mount Desert Rock. This rock is a small, barren island lying twenty miles south-southeast of Mount Desert Island, and some thirty miles from the mainland. Milan reported that bats do not inhabit this rock, but visit it in migrations every spring and fall.

Lasiurus borealis borealis Müller. Red bat.—One red bat was taken on August 23, 1935, by Reginald Linscott, on the Bar Harbor municipal pier; a second September 10, 1935, by William Stanley at Southwest Harbor. Specimen examined: ANP, 1.

Ursus americanus americanus Pallas. Black bear.—Bears are absent from the island at present, although they are reported to have been common formerly. Bailey (1925) writes, "Some of the old oak trees show bushy tops that were probably broken by bears in quest of acorns many years ago." Joe Tracy (age 77) of Somesville told Stupka, in 1933, that he had last seen bear tracks on the island about 1880.

Procyon lotor lotor Linnaeus. Raccoon.—Raccoons are occasionally seen along the roads at night, but they are not common. It is said they were plentiful on the island about 1900, but were trapped excessively. The plentiful supply of crustaceans, frogs, and shellfish would certainly support many more than occur at present.

Martes pennanti Erxleben. Fisher.—This species is now extirpated on Mount Desert Island. In the winter of 1924–25, O. Y. Thompson saw in the snow what he described as a fisher's track. Bailey (1925) writes, "His description answers perfectly the track of one of these animals, and it would not be surprising if one might have wandered to the island."

Mustela cicognanii cicognanii Bonaparte. Bonaparte weasel.—Three specimens are known, one obtained August 24, 1934, by M. L. Branin at Bliss Field, east of Champlain Mountain; one taken October 6, 1934, by Arthur Stupka on Dike Peak, the south shoulder of Cadillac Mountain, and the other killed by a domestic cat on June 26, 1936, and presented by Vernon Lunt at Town Hill. Specimens examined: ANP, 3.

Mustela frenata noveboracensis Emmons. New York weasel.—A "rather large weasel" reported by Thompson, in 1925, as "very common on the island," may have been this species. It is known from a single specimen collected at McKinley, with no accompanying data.

Mustela vison mink Peale and Beauvois. Mink.—Thompson and Smith (1933) reported forty minks on the island. Trapping and hunting with dogs have reduced their numbers in the past. Minks are seen rather frequently along the shores of salt water, or beside freshwater lakes and streams. One was taken in a Bailey beaver trap on September 27, 1934, by Lyle E. Smith at Round Pond. Specimens examined: ANP, 3.

Mustela macrodon Prentiss. Sea mink.—Prentiss (1903) described this species from a portion of a skull found in a shell heap at Brooklin, about eight miles west of Mount Desert Island, across Bluehill Bay. Subsequently many skeletal remains have been recovered from old Indian sites along the Maine coast, including Boynton's shell heap at Lamoine, across Frenchman's Bay from the island, as described by Moorehead (1922). The formal description of this species prompted Hardy (1903), of Brewer, Maine, to write a short account of it. As one of the chief fur-traders in Maine, over 50,000 mink skins had passed through his hands. He recognized as a distinct form a very large mink, skins of which were received from the Indians of the Penobscot and Jericho Bay regions until about 1860, and believed it to be this species. This large form was most highly developed on Swan's and Marshall's islands. Mrs. Fannie H. Eckstorm, a daughter of Hardy, wrote (1935, *in lit.*) that the "shore" or "seashore" minks were "much larger, very red brown, poorer quality of fur and with a pelt noticeably redder and a peculiar smell." She recalls seeing it in the 1870's, and believes it persisted somewhat longer to the eastward. Following Seton's note (1921), a mounted specimen was located in the collection of Clarence H. Clark of Lubec, Maine. This is an unusually large, light colored mink, collected at Campobello Island, New Brunswick, about 1894. It was examined by Norton (1930), who believed it to be *macrodon*. A photograph of this specimen, by Stupka, appears in Leopold's article (1936). It has seemed worthwhile to include here these data on this presumably extinct species.

Lutra canadensis canadensis Schreber. River otter.—This animal is scarce, if not extinct, on the island. It was last reported by Lyle Smith on March 11, 1935, when unmistakable tracks were seen leading from the outlet of Great Brook over Western Mountain. Smith had seen tracks of the otter frequently in this area in previous years and believed it crossed the island to enter the sea on the southwest side, frequenting beaver colonies en route. Bailey (1925) records, "In examining Aunt Betty's Pond we found fresh slides and signs along the shores and heard the call note of undoubtedly an old otter which had young nearby. . . . Their droppings were made up mainly of frogs' bones." O. Y. Thompson reports watching one eating frogs at New Mill Meadow about 1929. Such place names as Otter Creek and Otter Point attest to their former presence.

Mephitis mephitis nigra Peale and Beauvois. Striped skunk.—The skunk is a common animal in most parts of the island and is frequently encountered along the roads at night. In 1933 Thompson and Smith estimated there were 250 on the island and that their numbers were slightly increasing. Specimen examined: UMMZ, 1.

Vulpes fulva Desmarest. Red fox.—The abundance of foxes is, according to Bailey (1925), the reason for the scarcity of ruffed grouse and snowshoe rabbits on the island. Only occasionally is one seen in the wild. On June 18 an adult with two young, apparently only a few weeks old, was reported near Hadley Point. A silver fox was seen by O. Y. Thompson, about 1918, at the Ovens.

Lynx canadensis canadensis Kerr. Canada lynx.—Probably extirpated on the island many years ago. Bailey (1925) writes, "Undoubtedly they were originally native here, as apparently they covered all this northern country at one time."

Lynx rufus rufus Schreber. Bobcat.—Only a few records of bobcats on the island are available. Joe Tracy says he killed one in Gilmore Meadow about 1878. O. Y. Thompson believes one was present as late as 1925. Hardy (1909) writes, "My father once saw thirteen fully grown sheep which two wildcats had killed in one night on Mt. Desert Island."

Phoca vitulina concolor De Kay. Harbor seal.—Seals were nearly exterminated around the island when a bounty was offered on them about 1900. The Indians also used their skins for souvenirs. Today they are commonly seen in many places around the island, although their damage to weirs has resulted in some reduction by fishermen. In Western Bay they

are especially numerous and are seen in greatest numbers in the early spring when the ice is breaking up. At such times Vernon Lunt has seen 100 or more and Captain Rodney Sadler has reported 120 at once. The names Seal Cove, Seal Harbor, and Seal Rocks bear witness to their earlier abundance. Specimen examined: ANP, 1.

Marmota monax canadensis Erxleben. Woodchuck.—Bailey writes that in 1925 woodchucks were not known on the island, but that they were present on the adjacent mainland. Since then they have become established, although as yet they are uncommon. Thompson and Smith, in 1933, estimated twenty on the island and their numbers are slowly increasing. No specimens have been examined by the writer. Geographically, *canadensis* is the closest race. Howell (1915) lists one specimen examined by him from Columbia Falls, Washington County, which is some 30 miles from Mount Desert Island.

Tamias striatus lysteri Richardson. Chipmunk.—This is one of the most commonly observed mammals on the island. It frequents hardwood and coniferous forests, as well as meadows and the shores of fresh and salt water. Many are killed by automobiles. Altitudinally it ranges from sea level to the summit of Cadillac Mountain. The earliest spring appearance of the chipmunk was noted by Vernon Lunt on March 19, 1934; the latest fall occurrence, as noted by O. Y. Thompson, was on November 23, 1934. Autumn specimens had in their cheek pouches fruits of the following plants, as determined by Stupka: striped maple, sugar maple, red oak, and *Viburnum cassinoides*. Two specimens taken on September 9 and October 2, 1934, by Louis R. Fowler had in their cheek pouches, respectively, 102 and 168 seeds of the striped maple, with the blades removed. Specimens examined: ANP, 3; UMMZ, 3.

Tamiasciurus hudsonicus gymnicus Bangs. Red squirrel.—The red squirrel is abundant over the entire island, where it occurs mainly in coniferous forests. It ranges from sea level to the summits of several of the mountains. Globular outside nests are common. These are usually made of the *Usnea* lichens, as well as the loose bark of white cedar. Specimens examined: ANP, 3; UMMZ, 3.

Sciurus carolinensis leucotis Gapper. Gray squirrel.—This squirrel was probably not an original inhabitant of Mount Desert Island, although Joe Tracy reports seeing one at Indian Point about 1898. The present population dates from the spring of 1922, when captive specimens at Sieur de Monts Spring were released by George B. Dorr. They now range at least over the eastern half of the island. In 1933 Thompson and Smith estimated an increasing population of twenty on the island. Of the five specimens seen, four were killed by automobiles, one by dogs. Specimens examined: ANP, 3; UMMZ, 2.

Glaucomys sabrinus macrotis Mearns. Flying squirrel.—This nocturnal species appears to be rather common and widespread over the island. It is known from near sea level (Bar Harbor, Northeast Harbor) to the summit of Cadillac Mountain. In mid-September many were observed feeding on acorns an hour or so before midnight. On May 22, 1933, a female and three young were brought in by Mr. Dow, of the Mount Desert Nurseries. Mr. Dow stated that the young were born in a bureau drawer about four weeks earlier. Stupka (1935) describes an outside nest found occupied by four flying squirrels on December 19, 1934, south of the Tarn. This nest, a flattened sphere some ten inches in greatest diameter, was located about 20 feet from the ground in a small red spruce. It consisted largely of white cedar bark, finely shredded in the interior, as well as *Usnea* lichen and spruce twigs, and had a single entrance. Specimens examined: ANP, 6.

Castor canadensis canadensis Kuhl. Beaver.—The original beavers on the island were entirely trapped out in colonial days. The present population comes from two pairs released in 1920, under the supervision of George B. Dorr, on the stream flowing from Bubble Pond into Eagle Lake. So successfully have they become established that in recent years it has become necessary to live-trap and remove many to the western part of the island, where they are now plentiful. In 1934, while excavating muck at Great Meadow, distinct beaver cuttings were found six or eight feet below the surface. Erwin J. Raisz, a geologist, stated at the time that in this locality such muck would probably accumulate at the rate of about one foot per hundred years.

Peromyscus maniculatus abietorum Bangs. White-footed mouse.—Probably this is the most abundant mammal on the island. It is widespread, occurring in hardwood and coniferous forests, in marshes and occasionally in dwellings. It ranges practically from sea level to the summit of Cadillac Mountain. At the higher elevations it appears to be the most numerous species of mouse. On January 11, 1935, William Parsons discovered a nest with six adults in a hollow white cedar about twelve feet above the ground near Sieur de Monts Spring. Specimens examined: ANP, 132; UMMZ, 10.

Clethrionomys gapperi ochraceus Miller. Red-backed mouse.—This mouse is nearly as numerous as *Peromyscus*, and likewise occurs practically from sea level to the summit of Cadillac Mountain, chiefly in coniferous forests. The species is not strictly nocturnal, for several specimens were taken between noon and 4:00 p.m. Johnson (1927) found that this species and *Peromyscus* were approximately equal in numbers at intermediate altitudes, from 150 to 250 feet above sea level. A nest with five young, their eyes still unopened, was found on September 28, 1934, by Vernon Lunt near the Tarn. Specimens examined: ANP, 71; UMMZ, 7.

Microtus pennsylvanicus pennsylvanicus Ord. Meadow mouse.—This rodent is locally abundant in meadows, fields, and marshes throughout the island, but sometimes is taken in open woods. There are records from sea level (Sand Beach) to the summit of Cadillac Mountain, but it is more plentiful at the lower elevations. Specimens examined: ANP, 24; UMMZ, 2.

Ondatra zibethica zibethica Linnaeus. Muskrat.—Muskrats are well distributed in many marshes and ponds over the entire island. Their numbers have been kept down by trapping, but they now seem to be slightly on the increase. Specimen examined: ANP, 1.

Zapus hudsonius hudsonius Zimmermann. Meadow jumping mouse.—This mouse has been trapped in several widely separated marshes and meadows on the island, but is nowhere numerous. It has not been collected above 300 feet elevation. Branin (1936b) reports that in 1934 the last one trapped was on September 23. None was taken in October of that year by Stupka; but on December 11 two hibernating mice were dug up near the Kebo Valley Country Club from 14 inches beneath the surface of a clay bank. Batchelder (1899) described *Z. h. hardyi* from Mount Desert Island; this race is now regarded as a synonym of *hudsonius*. Specimens examined: ANP, 10; UMMZ, 3.

Napaeozapus insignis insignis Miller. Woodland jumping mouse.—Only two specimens of this species have been seen, one taken on May 9, 1936, by Maurice Sullivan at Sieur de Monts Spring, and the other on August 24, 1934, by M. L. Branin. The latter specimen "was caught at the edge of a mixed woods of oak, maple, birch and aspen, and at a point where this merges with the grassy tundra east of Champlain Mountain." Branin (1936a) further records that on September 7, 1934, Vernon Lunt unearthed an adult and nine young from a globular nest of leaves and dry grasses in a brush pile along a small creek in dense woodland south of the Tarn. Six of the young were taken alive, and subsequently released. Specimens examined: ANP, 2.

Mus musculus musculus Linnaeus. House mouse.—Occasional specimens are collected near public camp sites and picnic grounds, but they are not plentiful. Specimens examined: ANP, 9.

Rattus norvegicus Erxleben. Norway rat.—Specimens have been taken about deserted stables near the Bear Brook Campground. Several were seen, killed by automobiles along public highways. Specimens examined: ANP, 7; UMMZ, 1.

Erethizon dorsatum dorsatum Linnaeus. Porcupine.—Although extremely rare or absent on the island, the porcupine is present on the adjoining mainland. Bailey (1925) writes, "Apparently porcupines are not original inhabitants of Mount Desert Island, or if so, they must have disappeared long years ago. Mr. Thompson tells me that during his own and his father's lifetime on the island, they have not been known except two or three which were brought to the island about ten years ago and remained for a short time but later were killed." Joe Tracy reports that one was killed at Somes Sound about 1919. Lyle Smith saw one along

a carriage road on September 25, 1934; he believed it was one of several brought to the island about 1927.

Lepus americanus virginianus Harlan. Snowshoe rabbit.—This rabbit is widespread at all elevations over the island, but was not plentiful in 1939. Possibly predation by foxes is instrumental in keeping down their numbers, as Bailey (1925) suggests. He writes further, "These animals are rather scarce on the island at the present time, but Mr. Thompson says they were much more numerous two or three years ago." Vernon Lunt observed young, apparently just out of the nest, on May 20, 1933. Rabbits were observed in full winter pelage between November 28, 1934, and April 4, 1935. Lyle Smith and O. Y. Thompson report that 900 were trapped near Seawall in the fall of 1931 and shipped to sportsmen in Pennsylvania. Specimens examined: ANP, 2.

Odocoileus virginianus borealis Miller. White-tailed deer.—Deer are abundant over most forested portions of the island at all elevations. They are frequently seen along the roads. Miss Virginia Frost counted 163 deer in 77 days in this manner in the summer of 1939. Estimates of the total population range from 300 to the "thousands" reported by tourists; 500–600 would seem to be a safe figure. For some 30 years, except for one ten-day interval, there has been no legal hunting on the island. Vernon Lunt, in 1939, believed that some 100 were poached annually. Aside from this, the only apparent check on their numbers is predation by domestic dogs. Deer are known to cross to the mainland, but so few do that this cannot be of much importance in reducing their population on the island. Among their favorite foods on the island are American yew, mountain ash, red maple, and white cedar; several persons report that they definitely prefer old to young cedar browse. Mating was reported by Mr. Dow, at the Mount Desert Nurseries, on the night of November 8, 1934. Albino deer have been seen repeatedly in several distant sections of the island. Specimens examined: ANP, 2.

Alces americana americana Clinton. Moose.—Bailey (1925) writes, "Mr. O. Y. Thompson tells me that these great game animals once inhabited Mount Desert Island but have not been known here for at least two generations back." Joe Tracy reports that the last one on the island was a cow moose killed by dogs near Long Pond, about 1859. Tracy's uncle, Charles Clemont, recalled tales of boys collecting moose antlers shed in a winter yard at Hunter's Beach Brook. This would go back more than 100 years. There are frequent reports of vagrant moose on the island. One such report, apparently authentic, was of two moose landing on the shore near Duck Brook, about 1920, and breaking the glass in greenhouses there; they crossed the island and were last seen near Seal Cove.

Balaenoptera physalus Linnaeus. Finback whale.—Professor Ulric Dahlgren, of the Mount Desert Island Biological Laboratory, reports that for two months one summer two of these whales were seen occasionally near Googin Ledge, a point in the Narrows between the island and the mainland.

Megaptera nodosa Bonaterre. Humpback whale.—Arthur Stupka records that one of these whales was observed on August 10, 1934, and for thirteen consecutive days thereafter, in the vicinity of the Porcupine Islands, in Frenchman's Bay.

Phocaena phocoena Linnaeus. Harbor porpoise.—Schools of from two or three up to a dozen porpoises are not an uncommon sight in the waters surrounding Mount Desert Island. From July 4 to September 13, 1939, eight such schools were observed in Frenchman's Bay and the waters about the Cranberry Islands.

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STUDIES OF MOLTING AND PRIMING OF FUR OF THE EASTERN RACCOON

By Frederick W. Stuewer

This report is based on one phase of Raccoon Management Investigations, a Pittman-Robertson research project of the Game Division, Michigan Department of Conservation. The work was done at the Division's Swan Creek Wildlife Experiment Station, located in Allegan County in southwestern Michigan. Acknowledgment is made to H. D. Ruhl, Chief of the Game Division, for permitting use of the data. The information obtained on the Kalamazoo Hide & Fur Company's purchases for 1940 is greatly appreciated.

Field investigations for the project extended from February 1939 to July 1941. Box-trapping and handling live raccoons were intensively employed as methods of gaining much of the desired information. Thirty-four occupied dens were examined. By these methods, 256 raccoons were handled a total of 517 times. Some were taken in every month of the year, but more in summer than in any other season. Thus, the writer had the opportunity to examine a sizeable series of animals for condition of pelage. Observations concerning primeness of fall pelts is based principally on examination of pelts and data gathered at furbuyers' establishments.

Little more than passing mention of pelage changes and fur-priming of raccoons has been found in the literature. Bissonnette and Csech (1937), who conducted experimental breeding of animals with the addition of artificial light, noted that controls shed their winter fur after birth of litters, while those which bore young earlier than normally due to the lighting, also shed their fur earlier. Bailey (1926) says that in North Dakota an open season from November 15 to March 15 would probably insure prime fur. Other than the observations of these authors, information on priming of raccoon pelts seems to be entirely lacking.

Many of the findings by Gunn (1932a and 1932b) concerning molting and priming, principally of muskrats, seem to apply to most fur-bearers. Quoting him (1932b): "It is now clear that the sequence of the growth of new fur, of the priming condition, and of the moult is the same, and that the growth of new fur and the moulting proceed synchronously, but the prime phase is separated from these by a definite period of time." This appears to apply to raccoons, molting and growth of new fur taking place in spring and summer, and priming occurring in fall; but priming seems to proceed in a somewhat different pattern than in muskrats, as will be shown.

MOLTING

The first evidence indicating the onset of molt in wild raccoons was the small bunches of fur shed at dens examined in late April and May. That shedding begins at about the time young are born was shown by the finding of this fur in dens occupied by females and recently born litters. It was small in amount, never enough to indicate plucking by the animal to build a nest, as cottontails

do, for instance. A good opportunity to observe the progression of the molt presented itself in an albino raccoon held in captivity. The somewhat soiled and discolored old fur and guard hairs were in sufficient contrast with the new, white fur coming in to distinguish the two rather easily. In addition, the matted condition of the coat that was being discarded caused it to loosen and drop away more or less as a distinct layer above the new fur, the advance and pattern of which could be easily observed.

New white fur made a patchy appearance on the face of the animal in mid-April. The front feet showed a growth of new fur also, and thereafter this growth and molting proceeded together posteriad until the last patch of old fur dropped from the thighs and rump of the animal in late June. The advance appeared more rapid along the ventral part of the animal than on the dorsum. The pattern of shedding in wild animals was less conspicuous than in the albino, but the pelage condition was equally conspicuous. Due to molting and concurrent growth of the new coat, the majority of raccoons taken in July and August were rough in appearance. The characteristic condition in early summer was a pelage devoid of many of the guard hairs, with sparse, rough underfur, lacking the luster and sheen of the prime fall pelage. Tail fur was ragged, with practically all guard hairs missing on some individuals. Often the rear dorsum of an animal handled in June was sparsely furred, possibly due to the old fur being rubbed off in dens before the incoming hairs had appeared. By late August the new coat was distinctly visible. From that time on, the captured animals exhibited increasingly heavier and longer pelages, with the ultimate in appearance and quality being attained in the prime fur in fall and early winter.

PRIMING

Priming has been shown by Gunn (1932b) to be a phase in the life cycle of fur and hair, entirely separate in time and processes involved from molting and new growth. According to his studies (1932a), when fur primes, each hair migrates outward, devoid of an ampulla and pulled away from the papilla, which remains in the deeper part of the dermis. All vital connection is not severed, however, because changes stop if the hair is clipped off, whereas they continue in a hair left attached. These changes are manifest in depigmentation in the medulla of the proximal portion of the hair. The distance above the roots to which a shaft becomes devoid of pigment varies in different animals. Examination of raccoon hairs under the high power (440x) of a microscope by the writer shows this distance to extend somewhat beyond the epidermis (fig. 1). Such a condition is reflected in the raw pelts by the light areas of the underside. An unprime skin is dark on the flesh side because of the heavily pigmented hair roots imbedded in it.

The fur evidently is in the final stage of its cycle when prime, and remains so until shed the next spring. By late winter, however, before molting begins, it no longer has the best appearance, since it has become worn and often somewhat matted from prolonged denning previous to that time.

Pattern of priming.—Information on the progression and pattern followed by

the priming process of raccoon fur was secured by examining pelts in the possession of hunters and fur-buyers. Prime and unprime conditions were differentiated on the basis of light and dark areas, respectively, of the underside of the skin. From these observations, it appears that the pattern is much the same as that of molting. According to the condition exhibited by a fairly large number of pelts, hypothetical progressions of priming have been postulated, which are shown in fig. 3, D and E. A, B, and C (fig. 2) are sketches of three pelts, representing different stages in the phenomenon, which types are the basis for the sketches in D and E. From all pelts examined, it seemed evident that priming first begins on the ventral part of the raccoon. The process appears to progress from there towards the dorsal and posterior part of the animal, with either a narrow strip along the back, or a small area immediately anterior to the base of the tail becoming prime last.

Primeness of fall pelts.—All available evidence indicates that the fur of juvenile raccoons remains unprime later than that of adults. From the best indications, juvenile pelts usually are not prime until December, while most adult skins

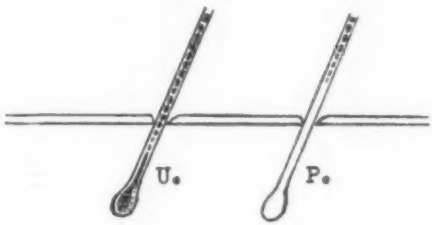

FIG. 1. Showing arrangement of pigment in prime (P) and unprime (U) fur hairs. (After Gunn, 1932)

ordinarily are prime by mid-November. Little information is available as to the extent of time from the onset until the completion of the priming process, but it is believed to be at least one and one-half months for raccoons in this latitude. The pelage of many animals was noted to be taking on a gloss and sheen, indicative of primeness, in October, but few became prime before mid-November.

In the fall of 1940, some information was obtained as to the condition of pelts taken during the present Michigan open season on raccoons. Hunting is allowed in the lower peninsula from November 1 to December 15. Trapping is legal in the northern half of the lower penisula from November 15 to December 15, and in the southern half from December 1 to December 15. Hunters take about 80 percent of the annual kill (34,645 in 1940). It is expedient to know what proportion of raccoon pelts taken are unprime, as a basis for continuing or modifying present seasons. To the extent that it is compatible with other interests, taking of raccoons should be at such a time as to insure the greatest number of prime pelts.

All fur-buyers (10) in Allegan County were interviewed and figures were obtained from the Kalamazoo Hide and Fur Company, one of the largest buyers in the state. The former were almost unanimous in reporting that pelts of juvenile raccoons usually do not become prime until near the end of the season, or in December, but that the majority of adult pelts are prime early in the season

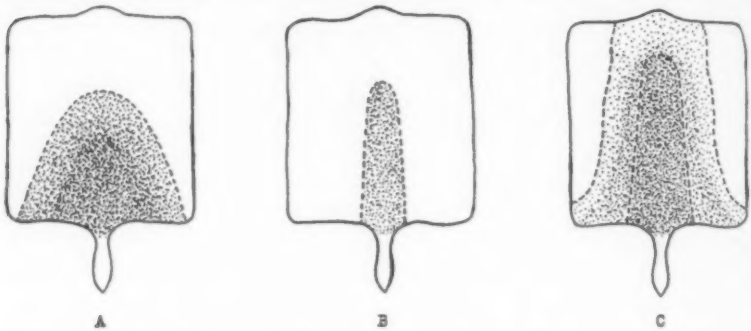

FIG. 2. Sketches from ventral side of raccoon pelts in different stages of priming. Stippled areas are dark and unprime, white areas light and prime. A, pelt with rear and most of back unprime; B, narrow strip extending along back from base of tail unprime; C, a pelt exhibiting three distinct bands in different stages of primeness

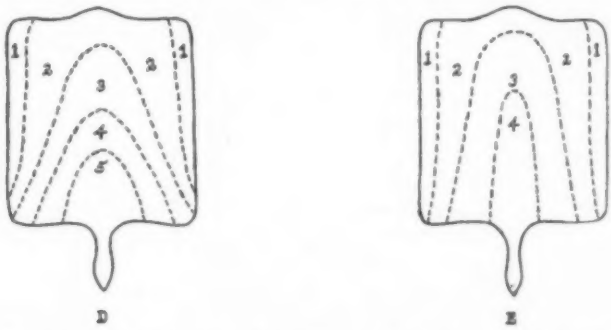

FIG. 3. Diagrams to show approximate patterns of priming of raccoon pelts. Numbered bands indicate progression of priming from outer edges of pelt, or ventral side of animal, towards the middle and rear, or posterior dorsal part of animal; D, small area immediately anterior to tail primes last in this case; E, narrow strip along back primes last.

or by mid-November. These data are supported by the writer's observations of pelts examined at buyers' establishments as the season progressed. Buyers' estimates of the numbers of unprime juvenile pelts taken each season varied from 30 per cent to "most of them", while all but one agreed that fewer unprime adult pelts were taken. That these figures are not far wrong is shown by data obtained at the Kalamazoo Hide and Fur Company, whose 1,081 medium and

small pelts (presumably the majority juveniles) numbered 57.64 percent prime and 42.36 percent unprime.

Table 1 shows the frequency and percentage distribution in classes of size and primeness of 5,214 raccoon pelts purchased by the Kalamazoo Company in 1940. Part of these pelts were from Indiana, but according to the company buyer, there is little difference in pelts from that state and from Michigan. This seems logical, since, although the state is somewhat farther south, which might cause priming to be later, Indiana's hunting season opens 15 days later than the season in Michigan.

Pelts were graded as to size into four classes: extra-large, large, medium, and small. Each of these was divided into prime and unprime lots. The buyer believed that all extra-large and most large pelts were from adult animals. Mediums probably included a few adults with the majority juveniles, and small pelts were all from juveniles.

TABLE 1.—*Frequency and percentage distribution in classes of size and primeness of 5,214 raccoon pelts purchased and graded by the Kalamazoo Hide and Fur Company in 1940*

	PRIME		UNPRIME		TOTALS	
	Number	Percent	Number	Percent	Number	Percent
Extra-large	1,275	85.81	211	14.19	1,486	28.50
Large	1,818	68.69	829	31.31	2,647	50.77
Medium	539	58.72	379	41.28	918	17.61
Small	84	51.54	79	48.46	163	3.12
Totals	3,716	71.27	1,498	28.73	5,214	100.00

Only 25.16 percent of the extra-large and large furs were classed as unprime, while 42.36 percent of the medium and small furs went into this class. This seems to be good evidence that juveniles furnish a considerably greater proportion of unprime pelts than do adults.

Table 1 shows a positive correlation between size and primeness of pelts. The percentages of prime pelts diminish through the classes from 85.81 percent of extra-large furs to 51.54 percent of the small furs. Grouping all skins together, 71.27 percent were prime and 28.73 percent unprime.

SUMMARY

1. A series of 256 live raccoons were handled in two years (1939–1941) in Allegan County, Michigan. Information relative to primeness of pelts taken in hunting and trapping seasons was obtained from 10 fur-buyers in Allegan County, and from the Kalamazoo Hide and Fur Company on their 5,214 raccoon pelts purchased after the 1940 season.

2. Molting and growth of new fur proceed synchronously, and in southwestern Michigan take place from mid-April to late June, although growth probably continues throughout the summer. Molting begins at the head, and progresses posteriorly, apparently more rapidly on the ventral part of the animals.

3. Priming is a phase in the life cycle of fur and hair, separate in time and processes involved from molting and growth, in which the medulla of the proximal portion of the hairs becomes depigmented. Primeness of a pelt can be determined by the light color of the underside due to lack of pigment.

4. Priming of a raccoon pelt appears to start on the ventral part and proceeds dorsally and posteriorly. Beginning in late October, about six weeks are required for completion. Fur of juveniles becomes prime two weeks to a month later than that of older animals.

5. Of 5,214 pelts taken by hunters and trappers, 71.27 percent were prime and 28.73 percent unprime. Of extra-large and large pelts, 25.16 percent were unprime, and of medium and small pelts, 42.36 percent were unprime.

6. Earlier opening of the season on raccoons in Michigan would increase the percentage of unprime pelts taken. Later opening would reduce this percentage, but would deprive hunters of the best part of the season for hunting with dogs.

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THE HYOID APPARATUS OF NEOTOMA

By James M. Sprague

Since the publication of my paper (Sprague, 1941) on the hyoid apparatus of the rodents of the subfamily Cricetinae, I have continued the study of the development of this structure in the cricetines. The genus *Neotoma* was chosen because of its size and availability. The aims of this study were to demonstrate, if possible, the presence of a tympanohyal, to homologize the segments of the anterior cornua (mentioned in the previous paper), and to check the myology of the hyoid complex.

Immature specimens of *Neotoma micropus* and *N. fuscipes*, cleared in potassium hydroxide and stained with alizarin red, were used to study developmental changes of the hyoid. These specimens were prepared by the technique suggested by Davis and Gore (1936) for animals that have been preserved for some length of time in alcohol, a modification of the method advocated by Dawson (1926). It was found in this study that maceration in the hydroxide could be retarded considerably by transferring the specimens from 70 percent to 95 percent alcohol before placing them in the clearing agent, rather than placing them directly in the hydroxide from 70 percent alcohol. Dissections of the muscles were made on adult alcoholic specimens of *N. fuscipes*.

The writer is indebted to Drs. Glover M. Allen, and Alfred S. Romer, Museum of Comparative Zoology, Harvard University, for frequent advice; to Dr. E. Raymond Hall, Museum of Vertebrate Zoology, University of California, for the loan of specimens of *Neotoma fuscipes*, and to Drs. H. E. Anthony and J. E. Hill of the American Museum of Natural History, for the loan of alcoholic specimens of *N. micropus*.

OSTEOLOGY

The presence and position of the tympanohyal are known for only a few rodent genera. Howes (1896) found no recognizable tympanohyal in adult specimens of *Oryctolagus cuniculus*, but he identified the small piece of bone articulated with the paroccipital process as the stylohyal. He concluded that the tympanohyal failed to ossify in *O. cuniculus*, and that the stylohyal consequently became attached to the paroccipital process and therefore opisthotrematic in position (*i.e.*, caudad to the stylomastoid foramen). He suggested that, coexistant with the close approximation of the paroccipital and mastoid processes and the expansion of the former in the Rodentia, the opisthotrematic position of the tympanohyal might be of frequent occurrence in this group. Howes noted, however, that in *Castor* the tympanohyal is well developed and protrematic (that is, craniad to the stylomastoid foramen).

Van Kampen (1905) noted that a distinct bony tympanohyal is found posterior to the stylomastoid foramen in *Georychus* and *Dasyprocta*. He felt that this element of the hyoid arch is usually indistinguishably fused to the mastoid process in the rodents. Van der Klaauw (1931) states that in many rodents the

tympanohyal is opisthotrematic, but cites no data other than the points mentioned by Van Kampen.

Fawcett (1917) indicated a tympanohyal protrematic in position in *Microtus amphibius*. De Beer and Woodger (1930) found a protrematic tympanohyal in the skull of the rabbit, *Oryctolagus*.

The writer (1941) found in certain cricetine genera that a ligament attached to the stylohyal cartilage enters the stylomastoid foramen in company with the facial nerve. Further dissection showed this ligament to be attached to the mastoid process, where the point of attachment is entirely covered by the bulla. Because no tympanohyal was evident in the adult skull, it was concluded that this element was entirely fused to the mastoid process.

A cleared and stained immature specimen (body length 50 mm) of *Neotoma micropus*, showed a distinct tympanohyal just medial to the upper end of the posterior leg of the tympanic annulus (fig. 1). This tympanohyal was only partly ossified and was attached at both ends by cartilage in the form of a loop, dorsally to the crista parotica and ventrally to the mastoid process. A later stage *N. fuscipes* (about 80 mm) showed the tympanohyal further ossified and more solidly conjoined with the mastoid process. Subsequent growth of the tympanic and the fusion of the posterior leg of the latter with the mastoid serve to cover completely the tympanohyal, which in the adult is indistinguishably fused with the surrounding region. The position of the tympanohyal in *Neotoma* is unquestionably protrematic.

The establishment of a tympanohyal in *Neotoma* makes relatively certain the homology of the elements found by the author (1941) in the anterior cornua of the Cricetinae. In certain genera of this group (*Onychomys*, *Reithrodontomys*, *Peromyscus*, and *Neotoma*) two bony elements were found in each cornu. The segment nearer the basihyal was found to be wedged into the basi-thyrohyal articulation; the following element is longer and blade-like. Attached to the latter by a short ligament is a long and styliform piece of cartilage, which extends to the posterolateral side of the tympanic bulla (figs. 2 and 3). This cartilage gives origin to the M. styloglossus and M. stylopharyngeus, and insertion to the M. stylohyoideus. Extending from this cartilage into the stylomastoid foramen is a rather ill-defined ligament, whose point of attachment to the mastoid process is covered by the bulla. Since the tympanohyal has been demonstrated to be fused to the mastoid process it is concluded that the cartilage represents the stylohyal. The muscular attachments of the latter substantiate this conclusion. The two ossified elements of the anterior cornu thus represent the ceratohyal and the hypohyal respectively. The ceratohyal gives origin to the M. constrictor pharyngeus superior, and the M. constrictor pharyngeus medius. It is not certain whether the ligament passing from the stylohyal to the mastoid process is actually a portion of the hyoid arch or merely a secondary connection.

The stylohyal cartilage in *Neotoma* was found to lengthen markedly as the animal grows. A subadult female (170 mm) showed a stylohyal 3 mm in length and quite straight, while this element in an adult male (220 mm) measured

7 mm and was considerably curved, with an obvious reduction of the ligament at either end (fig. 3).

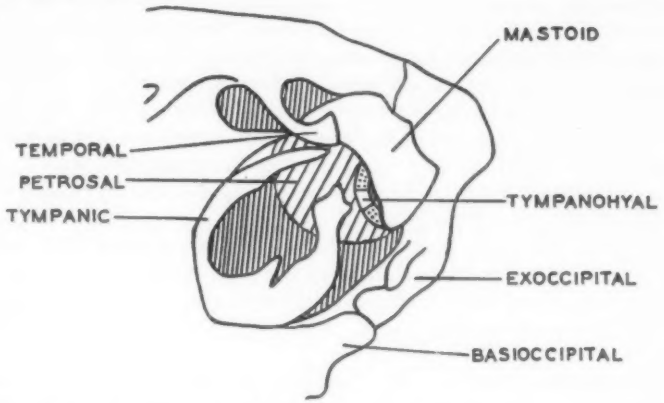

FIG. 1. Dorsally oblique view of the peritympanic region of *Neotoma micropus* to show the position of the tympanohyal. Cartilage in stipple. × 5.

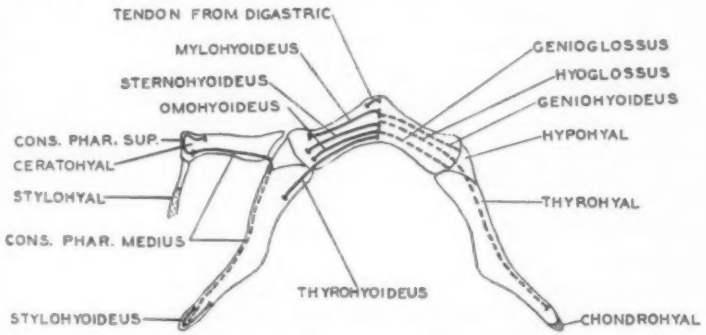

FIG. 2. Ventral view of the hyoid apparatus of *Neotoma fuscipes* to show the attachments of the muscles. Broken lines indicate dorsal attachment. Ceratohyal is extended laterally. × 4.

MYOLOGY

The Cricetinae is apparently the first group of muroid rodents in which a stylohyal has been found (Sprague, 1941). Tullberg (1899) mentioned that *Spalax* and *Gymnuromys* had two bony segments in the anterior horn of the hyoid connected by a short piece of cartilage. It is impossible from his figures and discussion to ascertain definitely the identity of these elements. Probably they represent the hypo- and ceratohyals. Tullberg cites as a character of the group Muriformes the single-segmented condition of the anterior horns of the hyoid; the above mentioned genera are his only exceptions. Therefore the

author felt that it would be valuable to check the musculature relating to this element and to the entire hyoid complex in *Neotoma*. Howell (1926) has worked out the myology of *Neotoma*, but his account did not include certain muscles of the hyoid apparatus, namely certain hyoid and pharyngeal muscles innervated by the glossopharyngeal and vagus nerves. The following discussion includes a description of the muscles not described by Howell, and certain other muscles which find attachment on the stylohyal cartilage. I have shown (figs. 2 and 3) the disposition of the muscles of the hyoid complex with relation to the hyoid apparatus. All dissections were made on *Neotoma fuscipes*.

M. stylohyoideus (fig. 3).—In rodents that lack a stylohyal, this muscle originates on the paroccipital (jugular) process of the exoccipital deep to the digastricus. In *Neotoma*, however, only the superficial fibers arise from the jugular process; the deeper fibers, making up most of the muscle, find their origin along the distal third of the stylohyal cartilage. Some fibers arise from the broad tendon of the styloglossus. The stylohyoid is inserted on the free end of the thyrohyal.

M. jugulohyoideus (fig. 3).—Hill (1936) mentioned the presence of a jugulohyoid in *Sciurus* and *Aplodontia*, but not in *Neotoma*; Howell (1926) likewise did not describe it. Deep to the superficial fibers of the stylohyoideus and not clearly delineated from them, a triangular group of fibers is found originating from the jugular process and inserting on the stylohyal, opposite the point of attachment of the stylohyoid. These apparently represent the jugulohyoid, a muscle frequently found when a stylohyal is present. When the latter is absent the stylohyoid originates on the jugular process, and a jugulohyoid is not distinct. The condition found in *Neotoma* appears to represent a transitory stage, in which the jugulohyoid is not completely separated from the stylohyoid, or conversely, the two muscles have not yet become fully fused. The pocket gopher, *Thomomys*, shows no stylohyal and no jugulohyoid, while *Sciurus* and *Aplodontia* have both (Hill, 1936). *Neotoma* thus appears to be intermediate in this respect.

M. ceratohyoideus (fig. 4).—This muscle originates from the distal half of the ceratohyal and inserts into the entire anterior margin of the thyrohyal. It is deep to the medial constrictor.

M. stylopharyngeus (fig. 4).—A thin and delicate muscle, deep to stylohyoideus, originates from the middle third of the stylohyal, and in passing toward the pharyngeal wall splits into two parts. The anterior part passes between the superior and medial pharyngeal constrictors and loses its fibers among those of the M. constrictor pharyngeus medius; the posterior fibers are lost among those of the M. constrictor pharyngeus inferior.

M. constrictor pharyngeus inferior (fig. 4).—Originating from a continuous line along the dorsolateral aspect of the thyroid and cricoid cartilages, this muscle runs obliquely anteriorly and dorsally to insert upon the median dorsal raphe of the pharynx. Although the inferior constrictor does not find attachment upon the hyoid apparatus, it has been included here to complete the constrictor group.

M. constrictor pharyngis medius (fig. 4).—Originating from the proximal half of the ceratohyal, this muscle spreads dorsally and caudally to insert into the mid-dorsal raphe of the pharynx. The medial constrictor is a small muscle

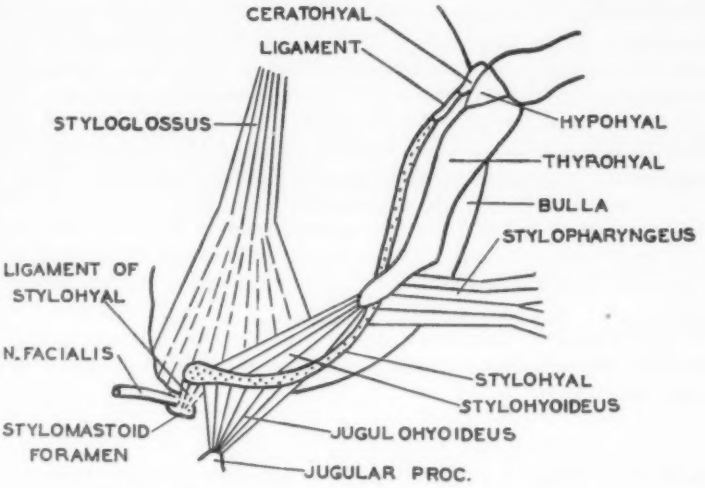

FIG. 3. Ventral view of the hyoid apparatus of *Neotoma fuscipes* to show the muscles. Broken lines indicate tendon or ligament, stipple represents cartilage. × 5.

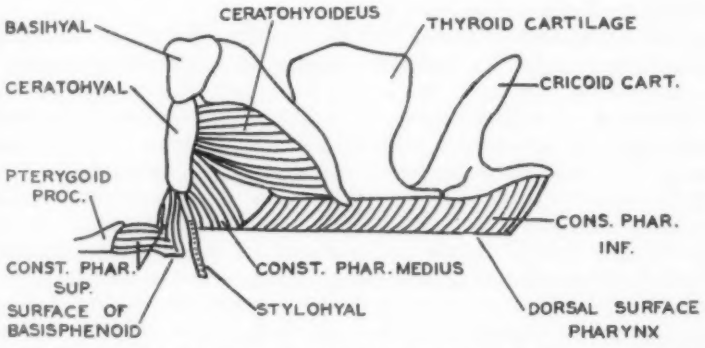

FIG. 4. Lateral view of the hyoid apparatus and laryngeal cartilages of *Neotoma fuscipes* to show the muscles. × 4.

and its caudal fibers are overlapped by the inferior constrictor. In the Cricetinae the thyrohyals are not directly connected with the anterior cornua of the thyroid cartilage, but extend lateral to it. The medial constrictor, which in most mammals originates from the thyrohyal as well as the ceratohyal, is here

reduced, apparently because of the position of the thyroid cartilage (and also the inferior constrictor) between the posteriorly projecting thyrohyals.

M. constrictor pharyngis superior (fig. 4). This muscle originates from the bucco-pharyngeal fascia, the hamular process, the posterior edge of the pterygoid process, and the tip of the ceratohyal. Some fibers also take origin from the basisphenoid bone. The superior constrictor in *Neotoma* is separated from the medial constrictor by the anterior cornu of the hyoid and the stylopharyngeus. The superior constrictor inserts into the mid-dorsal raphe of the pharynx.

M. styloglossus (fig. 3).—Howell (1926) has pointed out that in *Neotoma*, the styloglossus originates from a slight process upon the infero-posterior margin of the auditory meatus, rather than from the mastoid process as is usually stated to be the case in rodents. My findings agree with those of Howell in that the origin of this muscle is not from the mastoid process; in *N. fuscipes*, however, only a small part of its origin is from the auditory meatus. Most of the relatively broad tendon by which the styloglossus takes its origin is attached to the stylohyal.

M. genioglossus.—This muscle constitutes the medial portion of the tongue. Some of its fibers find attachment on the basihyal and the proximal tip of the ceratohyal.

SUMMARY AND CONCLUSIONS

1. All four segments of the anterior cornua, hypo-, cerato-, stylo- and tympanohyal, are present. A distinct tympanohyal, protrematic in position, is evident in immature stages of *Neotoma*, becomes partially ossified, and is later indistinguishably fused with the mastoid process. The stylohyal remains cartilaginous but is well developed.

2. The styloglossus originates from the stylohyal and the ventral margin of the auditory meatus. The superficial fibers of M. stylohyoideus originate from the paroccipital process, but the greater part of the muscle takes origin from the stylohyal. A jugulohyoideus, although not clearly delineated from the stylohyoideus, is present, and is inserted on the stylohyal. The stylopharyngeus and the three pharyngeal constrictors were also investigated.

3. The point of origin of M. styloglossus and M. stylohyoideus in rodents apparently is dependent on the presence or absence of the stylohyal. If present they originate from it. If the stylohyal does not develop, these muscles find their origin on the mastoid or paroccipital process. If a stylohyal is developed, a jugulohyoideus originates on the paroccipital process and inserts on the stylohyal, opposite the origin of the stylohyoid. When the stylohyal is lacking, the jugulohyoid is not differentiated and only the stylohyoid remains. In *Neotoma*, an intermediate condition exists. A stylohyal is present and both stylohyoid and jugulohyoid are evident. The superficial fibers of the two muscles are confluent, however; after these are removed the jugulohyoideus is evident.

4. From the incomplete separation of the jugulohyoideus and the stylohyoideus, it would appear that phylogenetically the stylohyal and probably the whole anterior cornua are becoming reduced in *Neotoma*. The conclusion that

such a condition is due to reduction is strengthened by the fact that the tympanohyal has become completely fused to the mastoid process in the adult.

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BREGMATIC FONTANELLE BONES IN THE GENUS LYNX

BY LORING W. PRATT

A resumé of the literature concerned with the occurrence of bregmatic fontanelle bones in mammals, and more especially with their incidence in the North American porcupines, *Erethizon dorsatum* and *Erethizon epixanthum*, and in the beaver, *Castor canadensis*, was published in 1923 by Schultz (Jour. Mamm., vol. 4, pp. 67–77). No mention was made in that paper of the genus *Lynx*, in which these bones also occur. A reference to the occurrence of a bregmatic bone in *Lynx fasciatus oculeus* was made by Bangs in 1899 (Proc. of New England Zool. Club, vol. 1, p. 23, March 31). No other reference to these bones in the genus *Lynx* has been found. From the study of a group of skulls of *Lynx canadensis* and *Lynx rufus*, made possible by those in charge of the collections of mammals in the American Museum of Natural History, the United States National Museum, and the United States Biological Surveys, the following data have been accumulated. The data from the Museum of Vertebrate Paleontology of the University of Kansas, and from the Museum of Vertebrate Zoology of the University of California are used with the permission of Claude W. Hibbard, Curator of Vertebrate Paleontology of the Museum of Vertebrate Paleon-

tology of the University of Kansas, who collected them and whose cooperation has been invaluable in the preparation of this manuscript.

The bones that are sometimes found filling the bregmatic fontanelle in *Lynx rufus* vary in shape to such an extent that their configuration is thought to be of little importance. Their occurrence, however, is of definite significance, because they are found to be present only in *Lynx rufus*, while entirely absent in *Lynx canadensis*. Plate 1 shows a group of tracings from the bregmatic region of specimens of *Lynx rufus* indicating the variation in the shape of the fontanelle bones, and also the sutural variations. In some skulls the frontals are fused, leaving only the coronal suture and the parietal part of the sagittal suture. All possible combinations of such variations may be seen in these skulls, and many of them are illustrated in Plate 1.

In specimens in which the bregmatic fontanelle bones occur, there is usually only one bone, placed at the junction of the coronal and sagittal sutures. Plate 2, figure 1, shows a normal skull with the junction of the sagittal and coronal sutures. Figure 2 illustrates the position of a single fontanelle bone between these sutures at the point where they normally cross. Figure 3 is of an infrequent type in which there are paired fontanelle bones in this position, and figure 4 the only specimen among the 2154 skulls examined that had as many as three fontanelle bones. All of the pictures are of *Lynx rufus*.

The occurrence of these bones, the number of skulls that could be studied with regard to this feature, and the collections in which the skulls are contained are listed in Table 1. Some skulls could not be studied, because of extensive breakage or because in old animals ankylosis of the bones had obliterated the sutures.

The incidence of occurrence of bregmatic bones averages 17.5 percent in the material studied, which is a series of a size sufficient to give a fairly accurate estimate of the true occurrence of the bones. The occurrence in males is 16.1 percent ± 0.88, while the occurrence in females is 18.7 percent ± 1.38. This clearly demonstrates that there is no statistically significant difference between these values. However, strangely enough, the percentage of 9.3 in the group of unknown sex is significantly different, but no reasonable explanation for this can be advanced by the author. This large variation indicates that some factor of selection is at work, but it has not been possible to detect it.

It was thought at first that the low percentage in the Unknown Sex group was due to contamination of the collections with skulls of *Lynx canadensis*. Upon this premise, the entire collections of the American Museum of Natural History and the United States National Museum were reexamined. The criteria for separation of *Lynx rufus* from *Lynx canadensis* by osteological characters of the skull were those proposed by Stock-Merriam (The Felidae of Rancho La Brea, Carnegie Institute, Washington). These characters are as follows: In *Lynx canadensis* (1) the skull is larger in the adult, (2) the auditory bullae are relatively smaller, (3) the postpalatine foramina are nearer to the orbital rim of the palate, and there is greater forward extent of the palatine as outlined by the maxillo-palatine suture, (4) the postorbital process is relatively smaller, (5) the condyle of the ramus of the mandible is relatively short in its transverse

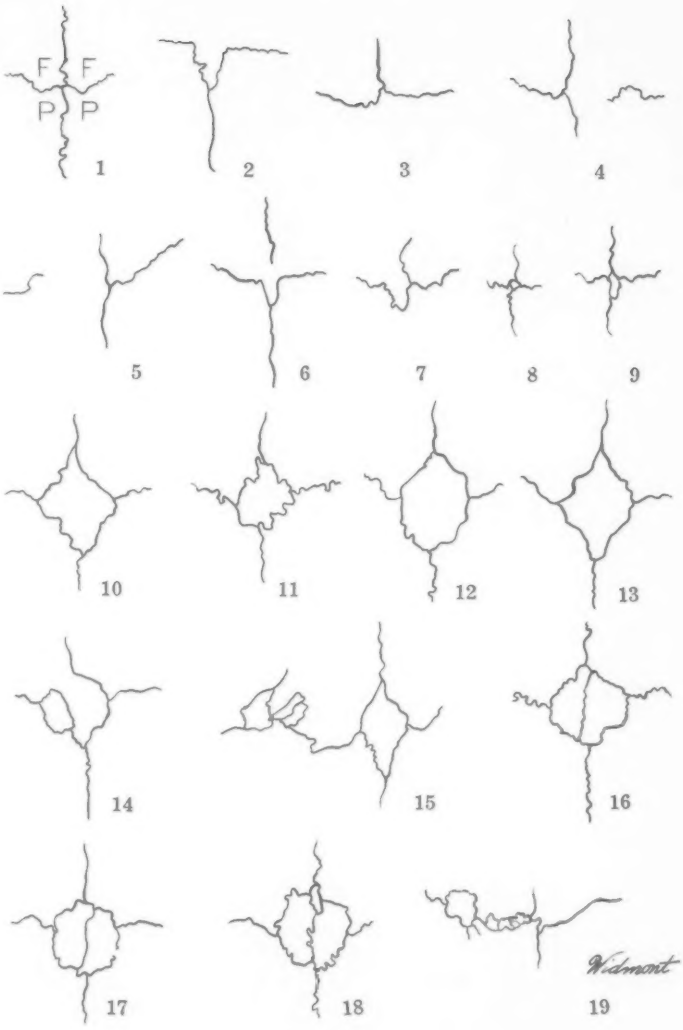

PLATE 1

1. Normal junction of sagittal and coronal sutures, with orientation of frontals and parietals: 2–7, Sutural variations in the bregmatic fontanelle: 8–13, Variations in size and shape of single bregmatic fontanelle bones: 14–15, Compound bregmatic and wormian bones: 16–17, Variations in double bregmatic fontanelle bones: 18, Triple bregmatic fontanelle bones: 19, Compound wormian bones in coronal suture. About 5/6 natural size. Drawn by Elinor Widmont.

PLATE 2

1. Adult *L. rufus*, showing normal skull top, Coll. U. S. Nat. Mus.: 2. Adult male *L. rufus*, showing position of single bregmatic bone, Coll. U. S. N. M.: 3. Adult male *L. rufus*, showing two bregmatic fontanelle bones, Coll. Biol. Surv. Coll.: 4. Adult female *L. rufus*, showing two large paired bregmatic fontanelle bones and a third, small bone located between and anterior to the paired bones, Coll. Biol. Surv. Coll. Photos. by author.

diameter, (6) the shape of the presphenoid is widened transversely and contracted anteroposteriorly. In *Lynx rufus* these features are all characterized by being opposite to those found in *Lynx canadensis*. The most useful of these characters is that of the presphenoid which is elongate and narrow in *Lynx rufus* as compared with the short wide bone found in *Lynx canadensis*.

TABLE 1.—*Occurrence, source, and number of skulls of Lynx rufus examined for fontanelle bones*

	U. S. NAT. MUS. BIOL SURV. COLL.	AMER. MUS. NAT. HIST.	U. S. NAT. MUS.	U. OF KAN.	U. OF CAL.	TOTALS	
No. of males with bregmatic bones	121	6	6	—	—	133	
No. of females with bregmatic bones	91	4	10	—	—	105	
Number of unknown sex with bregmatic bones	23	4	3	—	—	30	
Total	235	14	19	5	74		347
No. of males examined	758	38	30	—	—	826	
No. of females examined	499	23	29	—	—	561	
No. of unknown sex examined	236	39	48	—	—	323	
Total	1493	100	107	21	353		2074
						AVERAGES	
Percent of occurrence in males	16.0	15.8	20			16.1	
Percent of occurrence in females	18.3	17.4	30.5			18.7	
Percent of occurrence in unknown sex	9.7	10.3	6.3			9.3	
Average	15.7	14.0	17.8	23.8	21		17.5
						TOTALS	
No. of double bregmatic bones	6	0	0	1	5		12
No. of triple bregmatic bones	1	0	0	0	0		1
						AVERAGES	
Percent of double bregmatic bones	0.4	0	0	4.8	1.4		0.12
Percent of triple bregmatic bones	0.07	0	0	0	0		0.06

After reworking these two collections, it was found that the skulls in the Unknown Sex group were *Lynx rufus* upon the basis of the above criteria. This eliminates the most obvious of the sources of error, and no other source has been located; but without doubt some factor of selection is at work.

To account for the high percentage (30.5) of bregmatic bones found among 25 female *Lynx rufus* in the American Museum of Natural History, we must first

note that this group is a small series; in a larger series relatively fewer animals might have fontanelle bones. In addition, these particular skulls come largely from the South, where the bones may well occur more frequently than they do in northern animals.

In examining 617 specimens of *Lynx canadensis*, no occurrence of bregmatic bones has been found, nor, incidentally, in a series of 306 skulls of *Felis concolor*.

SUMMARY

Bregmatic fontanelle bones occur in 17.5 percent of *Lynx rufus*. Bregmatic fontanelle bones were not found in *Lynx canadensis*. The secondary sexual difference in the occurrence of bregmatic fontanelle bones in *Lynx rufus* is small and not statistically significant. There is no significant geographical distribution of specimens of *Lynx rufus* containing bregmatic fontanelle bones. Bregmatic bones have not been found in *Felis concolor*. Multiple bregmatic bones are found in *Lynx rufus*, paired bones occurring in 0.12 percent of the animals, and triple bones occurring in 0.06 percent.

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Henry Strong Dennison Scholar for 1942–43.

GROWTH IN THE DEER-MOUSE, *PEROMYSCUS MANICULATUS*

By Lee R. Dice and Robert M. Bradley

This paper describes the growth in body dimensions and in weight of seven subspecies of the deer-mouse, *Peromyscus maniculatus*, from the age of 15 days up to, for most of the stocks, 186 days. Arthur Svihla (1934, 1935, 1936) has presented growth curves of three subspecies (*artemisiae*, *bairdii*, and *oreas*) from birth to an age of 60 days. Our study therefore extends the analysis of growth in this species to a greater age than was considered by Svihla. The only subspecies for which the rate of growth has been studied both by Svihla and by ourselves is *bairdii*.

The junior author made all the measurements summarized here. Dr. Adolph Murie calculated the means of the measurements, but found himself unable to complete the preparation of the manuscript. The senior author directed the study and has written the report.

The three stocks of deer-mice from California and Baja California were presented by Dr. Francis B. Sumner of the Scripps Institute of Oceanography; the stock from Glacier Park was taken by Dr. Adolph Murie; the two New Mexican stocks were secured by the University of Michigan-Walker Expedition of 1927; and the Michigan stock was collected by the senior author. The necessary laboratory expenses for the study were defrayed by the Museum of Zoology, University of Michigan.

METHODS OF STUDY

Cages containing mated pairs of deer-mice were examined daily and the date of birth of all litters recorded. Measurements were not begun until the young mice were 15 days of age, because of the possibility of the mother refusing to accept again young mice that carried the taint of ether. Beginning at 15 days of age the mice were measured each third day until they were 36 days of age. Thereafter, they were measured at longer intervals, but in multiples of three days. These intervals usually, but not always, corresponded in the different litters of mice. The young mice usually were removed from their mothers at the age of 30 days.

All measurements were made while the mice were completely relaxed under deep ether anesthesia. The depth of anesthesia employed caused some deaths among the experimental animals so that nearly all the mice ultimately died from this cause. For this reason the number of measurements available for the older ages is considerably less than for the younger mice.

In preparing the graphs, all means based on the measurement of only a single mouse have been discarded. Accordingly every point on the curves is based on the means of at least two measurements. The maxium numbers of young mice available at any time for measurement in the several stocks were: *assimilis*, 8; *bairdii*, 6; *blandus*, 8; *osgoodi*, 13; *rubidus*, 6; *rufinus*, 6; and *sonoriensis*, 14.

The measurements employed are the standard ones used by mammalogists. *Body length* is the total length of the mouse from tip of nose to end of tail, minus the length of the tail. *Tail length* is measured from the rump, with the tail bent upward at a right angle to the body. *Foot length* is the length of the hind foot from the heel to the tip of the middle claw. *Ear length* is measured from the notch at the bottom of the external ear opening to the tip of the ear. Total length and tail length were measured with a rule graduated in millimeters. Vernier calipers reading to 0.1 millimeter were employed for the measurement of the foot and ear. The weight was taken on a beam balance and was recorded to the nearest 0.1 gram.

STOCKS EMPLOYED

The following subspecies and stocks of *Peromyscus maniculatus* were employed:

assimilis from North Coronados Island, Baja California.
bairdii from Ann Arbor, Washtenaw County, Michigan.
blandus from the White Sands, Otero County, New Mexico.
osgoodi from St. Mary, Glacier National Park, Montana.
rubidus from Carlotta, Humboldt County, California.
rufinus from Cloudcroft, Otero County, New Mexico.
sonoriensis from Victorville, San Bernardino County, California.

Measurements of the adult mice of the following stocks have been published previously: *assimilis* (Dice, 1941), *bairdii* (Dice, 1937), *osgoodi* (Murie, 1933), *rubidus* (Sumner, 1920), *rufinus* (Dice, 1933), and *sonoriensis* (Sumner, 1920, and Dice, 1935). The measurements of the adult *blandus* have not yet been prepared for publication.

GROWTH CHARACTERISTICS

The curves of growth here presented show numerous irregularities and in some measurements a temporary shrinkage occasionally is indicated. In part these variations are undoubtedly due to errors in measurement. It is not easy to secure an accurate measurement of a living mouse, even under deep anesthesia. Any error in measurement makes a considerable difference in the resulting mean when, as here, the number of individuals involved are few. Fluctuations are produced in some of the curves by one or more of the litters having been measured at age intervals different from those of the other litters of the subspecies. Irregularities in the curves also are sometimes caused by the death of a mouse that happened to be either an unusually large or an exceptionally small member of the series. A few actual shrinkages in size may have occurred from time to time, especially in weight. In general, however, the curves are fairly regular. No attempt has been made to smooth them in any way.

The two sexes possibly may grow at somewhat different rates, but the data are too few to justify an attempt to consider the males and females separately. In the adult mice of this species the males are heavier and have somewhat larger hind feet, but there are only slight differences between the two sexes in the other measurements (Dice, 1932, p.14; and 1933, p.7).

The curves of body length (fig. 1) for all the subspecies rise steeply from the fifteenth to near the thirty-third day of age, showing rapid growth of the animals during this early part of their lives. At about 33 days of age, the rate of growth of most of the subspecies begins to slacken and by the fifty-fourth day nearly all the stocks are growing in body length at a new and much slower rate than at first. The change in the rate of body growth between the ages of 33 and 54 days is not abrupt in any of the subspecies, but occurs gradually. After the age of 54 days nearly all the stocks continue to increase in body length slowly, but mostly rather steadily, until the age of six months, when measuring was discontinued. The growth curves of a few of the forms are irregular, however, especially of the subspecies *blandus*.

The subspecies with the greatest mean body length at the age of 15 days is *assimilis*; *blandus* is next. *P. m. assimilis* continues to exceed the others in body length until the age of 66 days, after which it is surpassed by *blandus*. *P. m. bairdii*, *osgoodi*, *rubidus*, and *sonoriensis* are intermediate in body length at most ages. At 114 days the mean of *osgoodi* begins a rise, however, which is correlated with the two longest-lived animals of the subspecies becoming very fat. The smallest subspecies at 15 days of age is *rufinus*, but some of the other subspecies average slightly smaller than *rufinus* at ages between 18 and 36 days. At ages between 46 and 186 days *rufinus* again averages smallest in body length.

Length of tail (fig. 2) exhibits much the same type of growth in these mice as does body length. The member increases rapidly in length at the younger ages, but at about four to six weeks of age the rate of growth begins to decrease. By eight weeks of age practically all of the stocks have reached a new and relatively slow rate of growth. This slow rate of growth in tail length continued, in the majority of the stocks, to the conclusion of the study.

FIG. 1. Growth in length of body in seven subspecies of *Peromyscus maniculatus*

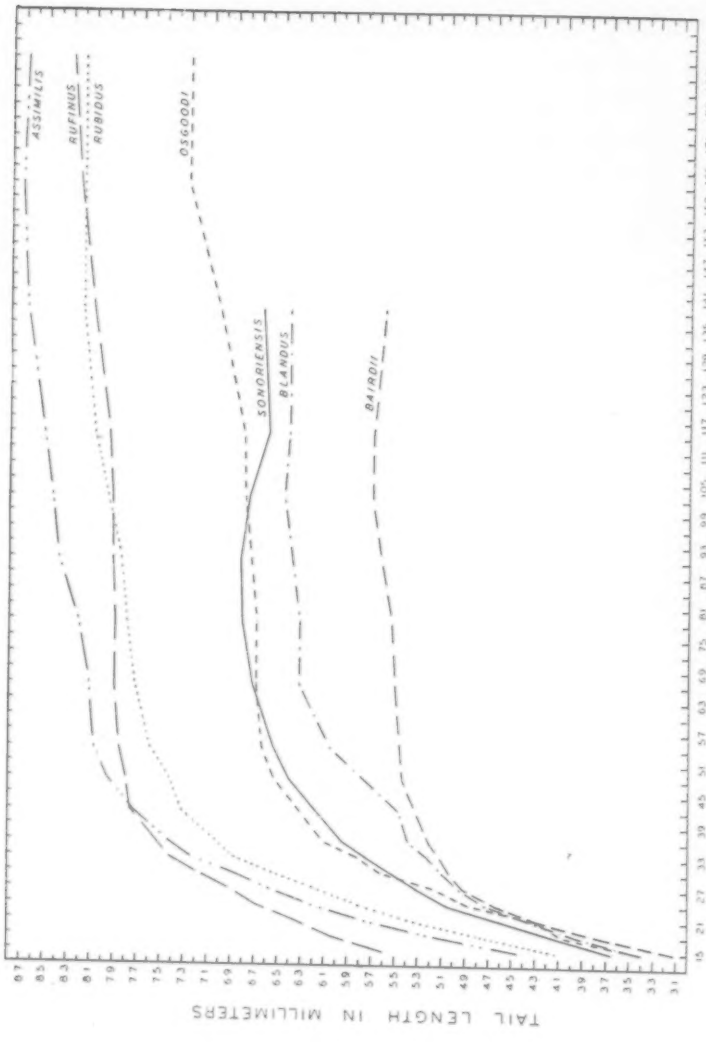

FIG. 2. Growth in length of tail in seven subspecies of *Peromyscus maniculatus*

The longest tails at the age of 15 days are possessed by the subspecies *rufinus*, with *assimilis* second, and *rubidus* third. At about 40 days of age *assimilis* comes to exceed *rufinus* in tail length and continues to have the longest tail of all the subspecies up to at least the age of six months. After about 15 weeks of age, *rufinus* and *rubidus* averaged about the same in tail length. The tails of *blandus*, *osgoodi*, and *sonoriensis* averaged intermediate in length throughout the period of measurement. *P. m. bairdii* averaged shortest of all the stocks in tail length at all ages.

The hind foot, like all the other dimensions of these mice, grows rapidly in length during early life (fig. 3). At about four weeks of age the rate of foot growth begins to slacken and at or before the age of six weeks in nearly all of the stocks the rate has decreased greatly. The break in this growth curve between four and six weeks is much more abrupt than in the curves for any other of the measurements. In a few of the stocks here considered, there is a small amount of increase in length of hind foot after the age of six weeks, but in some others there is no increase whatever in foot length between the ages of six weeks and six months.

The largest hind feet at all ages among this group of stocks are those of *assimilis*. *P. m. blandus* is next in order of foot size until the end of the period of measurement, when it is approached and perhaps exceeded by *osgoodi*. Subspecies *rufinus* averages smaller than *blandus* in foot length at all ages. *P. m. osgoodi* and *rubidus* both have irregular growth curves, which, in general, rank rather low among the stocks. *P. m. bairdii* and *sonoriensis* are the two smallest of all the stocks in length of hind foot throughout the period of growth, with *bairdii* usually averaging the smaller.

The ear grows rapidly in length from the age of 15 to 24 or 30 days, after which there begins a marked decrease in rate of growth (fig. 4). After the age of about six weeks the ear continues to grow slowly, but at a fairly even rate up to at least the age of six months.

The subspecies *rufinus* and *assimilis* have the largest ears of the forms here compared. These two forms are nearly alike in average ear size and both have larger ears at all ages than any other of the forms for which measurements are available. *P. m. blandus*, *osgoodi*, *rubidus*, and *sonoriensis* are intermediate in ear length, but somewhat irregular in their rank relative to one another at the various ages. *P. m. bairdii* averages the smallest of all the subspecies in size of ear at all ages.

Body weight increases fairly rapidly in these mice from the age of 15 up to, in the various stocks, about 42 to 54 days of age (fig. 5). There is not such an abrupt break at about six weeks of age in the curves of growth in weight as in the curves for growth in the body measurements. After 54 days of age most of the stocks continued to increase in weight slowly, but irregularly, until the conclusion of the study at about the age of six months.

The heaviest subspecies during the early period of growth was *assimilis*. During this time *blandus* was second in rank, but at about 54 days of age it came to exceed *assimilis*. The other five stocks all averaged light in weight

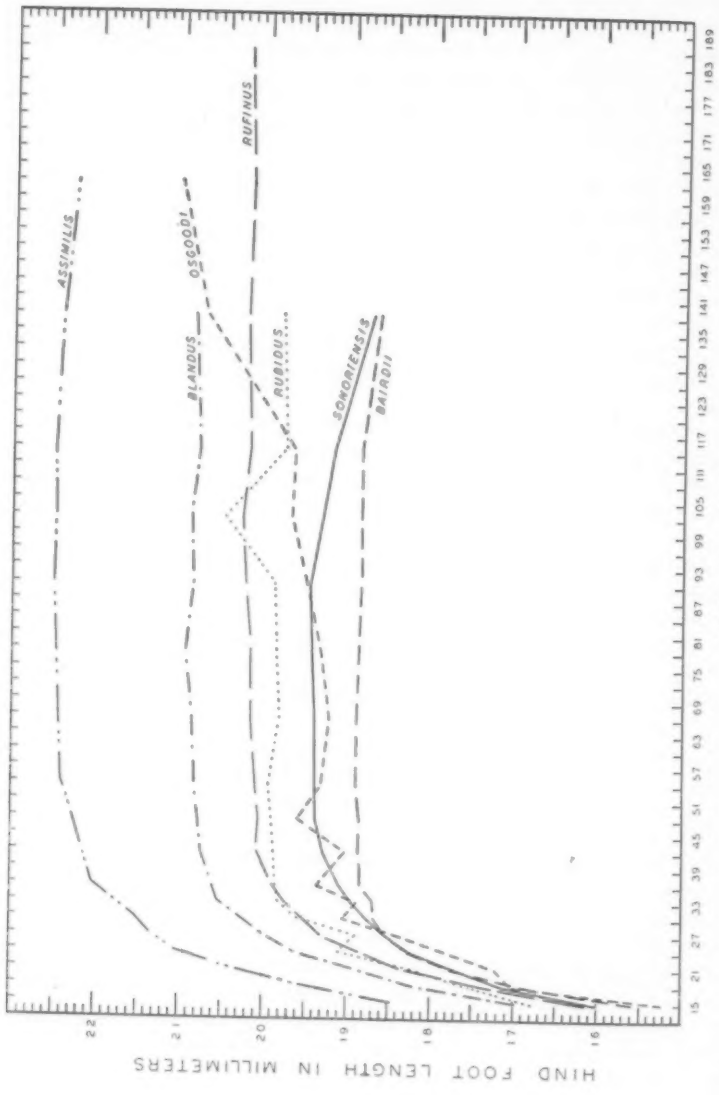

FIG. 3. Growth in length of hind foot in seven subspecies of *Peromyscus maniculatus*

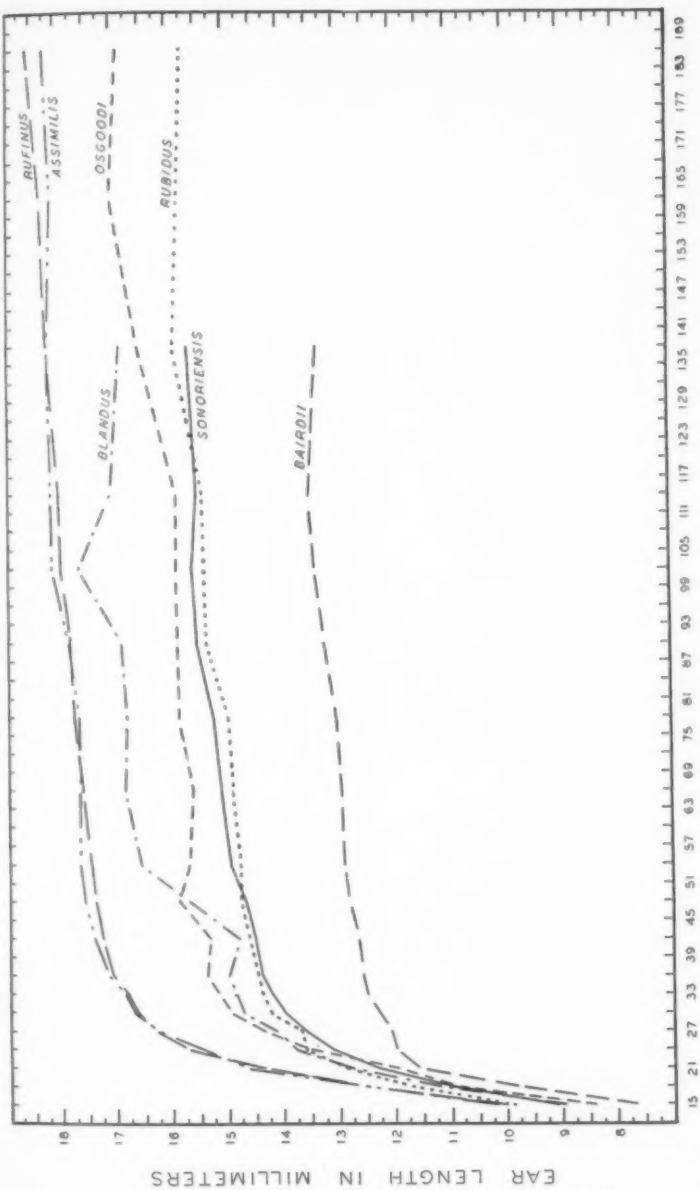

FIG. 4. Growth in length of ear in seven subspecies of *Peromyscus maniculatus*

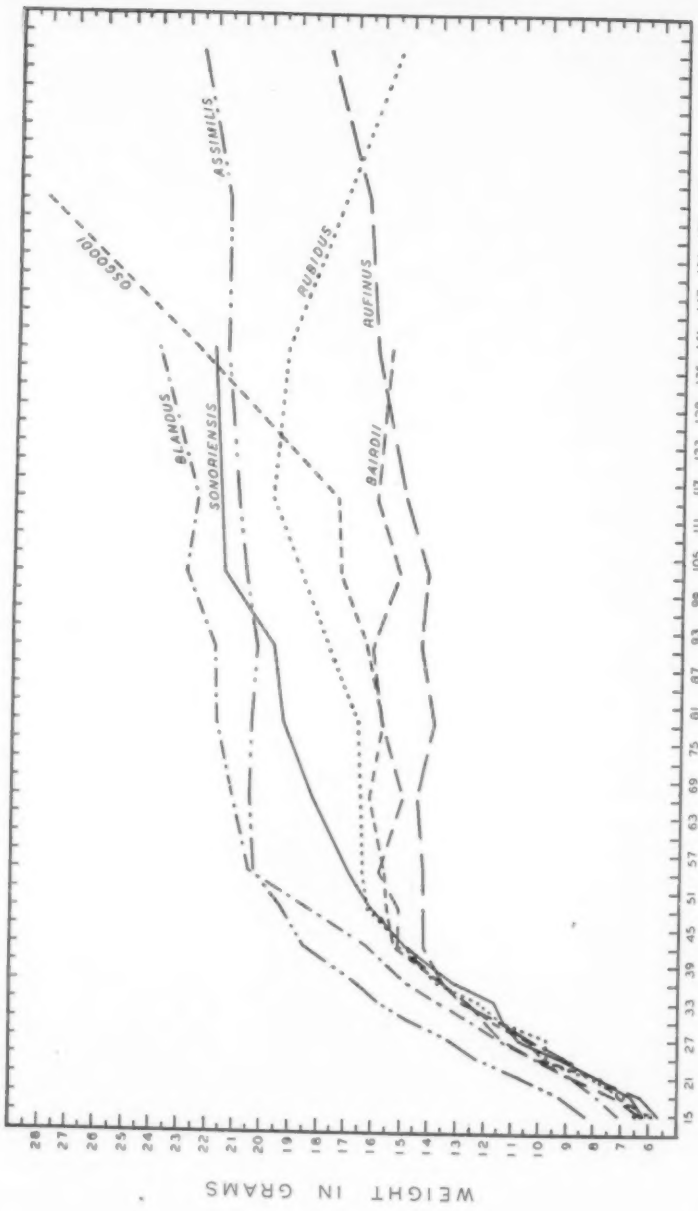

FIG. 5. Growth in weight of seven subspecies of *Peromyscus maniculatus*

up to the age of about 45 days and during this period their means remained close together. At the older ages many of the stocks became highly variable in weight and the curves then are irregular. At these older ages a few of the individuals became very fat.

DISCUSSION

The growth of young deer-mice is shown by the graphs presented above to proceed rapidly in all body dimensions up to ages of between 24 and 42 days. The weight increases rapidly from 15 to between 42 and 54 days. Following this juvenile period of rapid increase in size, the rate of growth begins to slacken and at or before the age of 54 days the growth of nearly all the subspecies has become established at a new rate which is much slower than that characteristic of their early life.

The ages at which the decrease in rate of growth takes place is indicated to vary somewhat with the size of the animal. In general those subspecies having the smallest adult dimensions begin to slacken their juvenile rate of growth at slightly earlier ages than those subspecies that are larger in size. This is especially well shown in the curves for growth in length of tail, hind foot, and ear, and in weight (figs. 2–5). In each of these graphs the curve representing the growth of *bairdii*, which is one of the smallest subspecies, begins to flatten out at an earlier age than the curve of *assimilis*, which is one of the largest subspecies. Those subspecies that are intermediate in size likewise begin to slow down in growth rate at ages which are intermediate between those of the very small and very large subspecies. In the graph of body length (fig. 1) the tendency for small subspecies to slacken growth at earlier ages than the larger forms is not so obvious.

The slow rate of growth in most body dimensions, which is established by these deer-mice at about six weeks of age, continues for at least a number of months. At the age of six months, when our study was terminated, the animals were still growing. Earlier studies by one of us have demonstrated that deer-mice of the subspecies *bairdii* (Dice, 1932, pp. 13–14) and *rufinus* (Dice, 1933, p. 7) continue to grow slightly in nearly all dimensions between the ages of one and two years. In the subspecies *gracilis* (Dice, 1936, pp. 55–57) some growth takes place after the age of two years.

Not all parts of the body of a deer-mouse grow equally rapidly. It is evident from the curves that tail length (fig. 2) increases slowly but steadily in all the subspecies between the ages of about six weeks and six months. In most of the subspecies there is also some growth between these ages in length of body, and ear, and in weight. On the other hand, the hind foot (fig. 3) grows only a small amount after the age of six weeks. Actually several subspecies failed to grow at all in length of foot between the ages of six weeks and six months.

The change in rate of growth between the ages of four and six weeks, which is so evident in all the curves of growth here presented, is also apparent in the growth curves published by Svihla (1934, 1935, 1936). It is not so obvious, however, in Svihla's figures because of the flat scale there employed.

That weaning of the growing mice at about the age of 25 days may be in part responsible for slowing down the growth rate has been suggested by Svihla (1934, pp. 102–104). In the graphs here presented, however, it appears that only in ear-length is there any evident slackening of growth rate in any of the subspecies before the age of 27 days. At about four weeks of age, most of the subspecies begin to slacken their rate of growth in the dimensions of the body, but it is not until the age of six weeks that most of the forms have decreased their speed of growth to the subadult rate. Attention is especially called to the graph of weight correlated with age (fig. 5), where it appears that all seven of the subspecies continued to grow approximately at the same rate between the ages of 15 and 42 days. A few subspecies continued to grow fairly rapidly in certain dimensions after the age of six weeks, but, in these forms also, the subadult growth rate was soon thereafter established.

The approach to sexual maturity is probably an important factor in the slowing down of the growth rate of these mice. It has been demonstrated by Clark (1938) that the females of *Peromyscus maniculatus* have their first estrum at the average age of 48 days, but that some females come into estrum at a much earlier age, the youngest reported being 28 days old. Some males of the species contain motile sperm and are therefore possibly sexually mature at the age of about 40 days. These ages of attaining sexual maturity correspond well with the ages at which the young deer-mice change from a high juvenile rate of growth to a much slower, subadult rate.

Races of deer-mice that are relatively large or small in any dimension at birth tend to retain these size relationships as they grow to adult size. This has been pointed out by Svihla (1935, 1936) for the period from birth up to an age of about 60 days. It seems to be true also of the forms which we have had under observation between the ages of 15 and 186 days. Although the numbers of animals in all our stocks were few and the curves of growth somewhat irregular, the graphs in general support Svihla's conclusion. In domestic rabbits, likewise, Castle (1929, pp. 424–425) has earlier shown that the differences in weight which distinguish a smaller from a larger domestic variety are apparent at birth.

SUMMARY

Data are presented on the growth of seven subspecies of the deer-mouse, *Peromyscus maniculatus*, from 15 days to about six months of age.

The deer-mice grow rapidly in all body dimensions and in weight until they are about four to six weeks of age.

It is indicated that those subspecies which have the smallest adult dimensions begin to slacken their juvenile rate of growth at slightly earlier ages than those which are larger in size.

After the age of about six weeks, growth in length of body, length of tail, length of ear, and in weight, continues at a slow rate up until the age of six months or older. The hind foot, however, increases in length only slightly, or in some stocks not at all, after the age of six weeks.

The slowing in the rate of growth of the young deer-mice at about the ages of four to six weeks is correlated in time with their approach to sexual maturity.

Races of deer-mice that are relatively large or relatively small in any dimension at birth tend to retain these size relationships as they grow to adult size.

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DESCRIPTION OF BIRTH AND YOUNG OF THE POCKET GOPHER, *GEOMYS FLORIDANUS*

By B. A. Barrington, Jr.

In the literature I have found only two descriptions of pocket gophers which indicate the condition of these animals at birth. New born young of *Thomomys bulbivorus*, which were born in captivity, are briefly described by Wight (Oregon Exp. Sta. Bull. No. 153, 1918, pp.13–15). Two young of *Thomomys bottae* are described in considerable detail by Hill (Jour. Mamm. vol. 15, 1934, pp. 244–245). He states that they were probably not much more than one day old because a small part of the umbilical cord was attached to one and the entire cord and part of the placenta to the other. On account of the scarcity of information concerning new born pocket gophers, the birth and young of a litter of three *Geomys floridanus* are described below.

A female *Geomys floridanus*, taken at Gainesville, Florida, that had been kept in the laboratory for about a week was observed on May 2, 1939, to have an unusually large and swollen vulva, which I suspected was evidence that she would soon give birth to young. Two days later the young were born.

My attention was attracted at 9:38 p.m., May 4, by hearing her emit several sharp squeaks. Examination showed that the amnion had apparently ruptured recently as the region around the vaginal orifice was wet. Approximately two minutes later the first young was born. Parturition of the second young was observed by Dr. H. B. Sherman, W. K. Smith, and myself.

After the birth of the first young, she appeared to have spasmodic labor pains at frequent intervals. At 10:50 p.m. she spread her hindlegs and arched her tail dorsally. After remaining in this position for five minutes the second young arrived. The third made its appearence at 11:39 p.m. The mother apparently suffered no severe labor pains with the birth of the last.

In the two cases observed the young were born tail-end first, and birth was complete within two seconds of their first appearence at the vaginal orifice. In each instance the amnion had ruptured before birth and the young were not noticeably moist when born. The umbilical cord broke close to the body of the young at birth, with no apparent assistance on the part of the mother. In fact she remained inactive until, and after, the discharge of the afterbirths.

Afterbirths were passed 22, 42, and 49 minutes after the birth of the last young, and the first passed weighed one gram. Little bleeding accompanied the extrusion of the first, a little more with the second, and much more with the last afterbirth. The mother made no atttempt to eat them although they were left in the cage.

After parturition was completed the mother appeared exhausted, but she gradually became more active and by 1:10 a.m. was vigrously digging in the sand.

The newborn young crawled in a clumsy manner and they emitted a peculiar squeaking noise that resembled the sound produced by pulling a rosined string through the fingers. When attempting to nurse they turned on their backs and, by pushing against the body of the mother with their feet, wriggled along, upside down, until they found a teat.

The general appearence of one of these newborn *Geomys floridanus* is shown in the accompanying figure. The body is covered with a pinkish, loose, wrinkled skin. Vibrissae are present on the sides of the face, and a few, short, hairs are scattered about on the dorsal surface of the body. Neither the eyes, ears, nor cheek pouches are open. There is a pronounced furrow in the skin at the sides of the mouth, however, where in the adult the cheek pouches are located. The

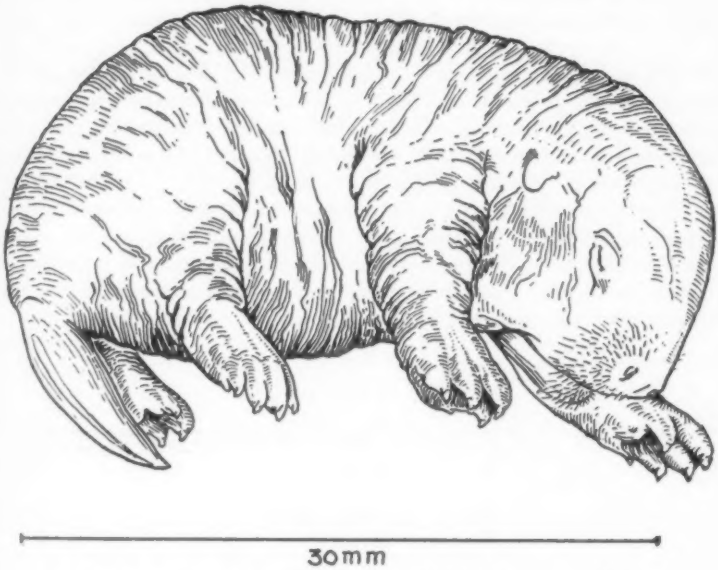

FIG. 1. New born *Geomys floridanus*. (Drawing by W. Brudon)

TABLE 1.—*Measurements and weights of young pocket gophers shortly after birth*

SPECIES	TOTAL LENGTH	LENGTH OF TAIL	LENGTH OF HIND FOOT	WEIGHT IN GRAMS
Geomys floridanus	52	9	5.5	5.10
" "	50	9	6.0	5.20
" "	50	9	5.3	5.10
Thomomys bulbivorus	50	—	—	6.12
Thomomys bottae	49.5	9	6.0	4.00
" "	50.5	9	6.0	4.20

toes of both fore and hind feet are short, those of the fore feet being the longer. The teeth have not errupted.

The weights of the three newborn immediately after birth, and before nursing, were 5.2, 6.2, and 6.5 grams. Two of the young died May 5, and the third was found dead the morning of May 6. All apparently died of exposure since the mother could not build an adequate nest with the material in the cage. The

measurements of the young, soon after death, together with measurements of newborn *Thomomys bulbivorus* (Wight *op. cit.*) and of very young *Thomomys bottae* (Hill *op. cit.*) are given in Table 1.

From these measurements it appears that the sizes of the newborn young of these three species are nearly the same.

The stage of development of the cheek pouches of young pocket gophers varies remarkably, however, as shown by the following statements: In *Geomys floridanus* a wrinkle in the skin at each side of the mouth in the newborn young is the only indication of the pouches, as determined by dissection. The newborn young of *Thomomys bulbivorus* do not have pouches, but they develop at the age of one month, according to Wight (*op. cit.*). In a young specimen of *Thomomys bottae pallescens*, the body length of which was three and one half inches, the pouches are only indicated by a wrinkle in the skin at the sides of the mouth, according to Anthony (Jour. Mamm. vol. 4, no. 2, 1922, pp. 126–127). In *Thomomys bottae* (subspecies *bottae*, personal communication from Hill) the pouches are well developed in the very young and even in the 18 mm fetus.

From the above statements, concerning the four subspecies of pocket gophers for which information is available, it is evident that *Thomomys bottae bottae* is exceptional in that cheek pouches are present even before birth.

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SUMMER ACTIVITIES OF BATS (*GENUS LASIURUS*) IN IOWA

By H. Elliott McClure

During extensive observations of the nesting habits of the mourning dove in 1938 at Lewis, Iowa, northern red bats (*Lasiurus borealis borealis*) were noted in some abundance. Casual observations in 1938 stimulated a more thorough search for them in 1939. Whereas only 55 bat records were made in 1938, 765 observations were made in 1939. The 1938 and 1939 figures included repetitions of bat families observed time and again. The area under observation comprised 160 acres and included 1,650 trees of 35 species. These trees were examined every other day for bats that might be roosting in them. Inasmuch as bats appeared as dark brown patches against the leaves, they were readily observed.

Both the northern red bat and the hoary bat (*Lasiurus cinereus*) were present, but, as indicated by Scott (1937) and Swenk (1915), the hoary bat was most common in spring and fall during migrations. Of the 765 records only 46 were for hoary bats, and most of these were noted before July 15. A few were seen early in September. Young of both the red and hoary bats were born in June and the first of July and three females each with two young were observed at this time.

In 1939, the first red bats were seen on May 1, but from then until June 28 they were not numerous. From June 28 to July 24 the numbers observed increased with regularity. After July 24 they decreased until September 13 when

the last bat was seen. On July 24, 70 bats were counted, more than were noted in the entire season of 1938. Although only a few bats were recorded in 1938, they show the same trend of seasonal abundance as in 1939 (fig. 1).

The first parent bat with young clinging to her was seen June 28, 1939, and the last family group in a cluster was noted August 24, 1939. By the latter date all young were grown and in the field it was impossible to distinguish parents from young. The number of young with a parent ranged from one to four, but the average was 2.3. During the day each family clustered about its

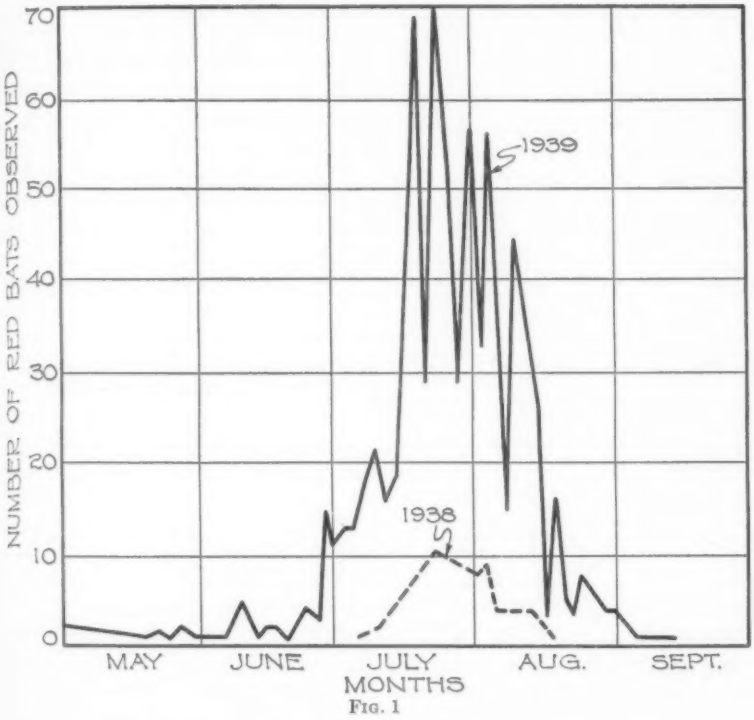

FIG. 1

mother, or she rested a short distance from them. By July 17 many families had broken up. In this period of growth some young were observed exercising every hour of the day. They stretched their wings, wiggled, and swung. When the temperature of the air rose above 30°C. the bats cooled themselves by hanging, stretched to full length, with the wings slightly drooped. At any disturbance they contracted into bundles. In August, family clusters under observation disappeared one by one.

It is estimated that at the peak of activity, in mid-July, there were 150 bats in the area; it is doubtful if more than 50 percent were ever seen on one day. This

is a concentration of about one bat per acre. Many single bats were noted that were probably males or unmated females; however, it was estimated that there was a population of 35 families, or one family to every 4.5 acres in the area. A similar concentration of bats was not seen away from town in either farmyards, woods, or gullies. Concentration in town may result from abundant food supply in the evenings around street lights.

Location of Roosts.—Parents left their young clinging in 24 species of trees and in vines and porches. They seemed to have no special choice of trees,

TABLE 1.—*Use of trees by northern red bats at Lewis, Iowa*[1]

SPECIES		PERCENT OF BATS OBSERVED	PERCENT OF TOTAL TREES IN TOWN
American elm	*Ulmus americana*	60.1	33.0
Box elder	*Acer negundo*	7.5	15.6
Norway spruce	*Picea abies*	5.3	1.0
Soft maple	*Acer saccharinum*	3.5	7.0
Apple	*Pyrus malus*	2.8	10.0
Pear	*Pyrus communis*	2.8	0.5
Hard maple	*Acer saccharum*	2.8	0.5
Catalpa	*Catalpa catalpa*	2.7	1.5
Birch	*Betula* spp.	2.2	0.3
Cherry	*Prunus avium*	1.1	5.5
Chinese elm	*Ulmus orientalis*	1.0	1.9
Hackberry	*Celtis occidentalis*	1.0	0.7
Scotch pine	*Pinus sylvestris*	1.0	0.7
Tree of Heaven	*Ailanthus glandulosus*	1.0	0.2
Ash	*Fraxinus* spp.	1.0	3.0
Black walnut	*Juglans niger*	1.0	5.6
Cottonwood	*Populus deltoides*	0.5	0.4
Choke cherry	*Prunus virginianus*	0.3	0.1
Colorado blue spruce	*Picea* sp.	0.2	0.4
Red pine	*Pinus resinosa*	0.2	1.0
Mulberry	*Morus rubra*	0.2	1.2
Tamarack	*Larix laricina*	0.1	0.1
Peach	*Prunus persica*	0.1	0.7
Plum	*Prunus americana*	0.1	0.5

[1] This table compares the percentage of bats observed roosting in each species of tree with the relative abundance of each tree.

although American elms were the most abundantly used. Elms made up 33 percent of the town's trees, and 60 percent of the bats noted were in them. Box elders, which made up 15.6 percent of the trees, were used by only 7.5 percent of the bats; and apple trees, making up ten percent of the trees, were used by only 2.8 percent of the bats. The animals roosted from 5 to 40 feet above the ground, and the height of a tree seemed not to alter their choice of it. Probably the pendulous limbs and broad protecting crowns, plus large rough leaves, made elms attractive. Further information concerning bat roosts and tree relationships is presented in Table 1.

Use of Roosts.—Although no bats were marked, it became apparent as the season progressed that a given bat used the same roost day after day. Each of several bats not only used the same tree, but clung to the same leaf or limb each day. Following are records concerning seven such instances:

I. A family made use of a limb of a Norway spruce. The tree was 12 inches in diameter and the roost was 8 feet from the trunk and 15 feet above the ground on the north side of the tree. A bat was making use of this site after June 19, and on June 30 one appeared with two young clinging to it. They were found regularly on the limb until July 10, when only one young bat was left. On July 14, an adult was with this young and they were hanging from their usual place. At this date there was but little difference in size. After July 19 the two no longer clung to each other, but roosted on separate twigs. They remained until July 31. Each day between July 31 and August 11 a bat was in the tree, always at a place different than the one occupied on the preceding day. More than one bat may have been concerned.

II. A lone bat, probably a male or unmated female, chose one single leaf in a small elm as its roost. The tree was four inches in diameter and the leaf seven feet from the ground and three feet out on a limb on the north side of the tree. The bat was on this leaf for 42 consecutive days. After August 30, it was not seen until September 13 when either it or another one made use of a leaf near the old roost.

III. A family roosted on a bunch of leaves on a low hanging limb of a large elm tree. The tree was 30 inches in diameter and the roost was on the north side 8 feet from the ground and 20 feet from the trunk. One parent and four young were first seen there on July 24. They used the roost until August 2, when only one young bat was present. On August 4 they were all back together. Usually the four young clung together on one leaf, while the parent roosted alone nearby. On August 11 only three bats were present; on August 14, two; and on August 16, one. One was found each day until August 23.

IV. One bat used a roost 15 feet from the ground and 7 feet from the trunk on the south side of a Scotch pine from July 21 to August 2.

V. A family in a large hard maple tree did not remain clustered as long as many others. It roosted in various places on a limb 12 feet above the ground on the north side of the tree. On July 19 a parent was present with three young in a cluster and one young was by itself. The group remained until July 28 when only one young bat was there. On August 2 two bats were in the tree, but not together. On August 4 they were roosting together. After this date one was seen intermittently using the same roost until August 21.

VI. On July 31 a parent and three young were clustered under a leaf of a pear tree. They were eight feet from the ground and one foot from the trunk on an east-facing limb. On August 2 two young were present. Then the whole family used the roost again until August 11. From that date to August 24 one young bat was there each day.

VII. On May 13, 1940, a hoary bat was noted clinging to the limb of a Norway spruce. She used this roost almost every day. At some time in the two days

before June 12 she gave birth to two young. By June 25 each was almost as long as her contracted body. By June 29 they were too large for her to carry when she was foraging, but they clung to her during the day. While small, their fur was reddish brown, but when they were about three weeks old, the hair began to take on the grizzled appearance of the adult. On July 9 it was found that the family had broken up; probably the young had practiced flying before this date. On July 10 they were all back together, but two days later they were gone.

Decimating Factors.—Only two dead bats were found, one after a heavy hail storm on June 8, and a young one that was killed in a wind storm on July 19, 1939.

On one occasion a parent was observed with two young under a leaf at the tip of a twig high in an elm. They were seen also by a blue jay that immediately attacked them, but they were in such a position that the jay could not readily strike them. It flew from twig to twig trying to find a point of attack, while the parent bat kept up a constant "ticking". When the blue jay found a position from which it could strike the bats, the adult hissed and struck at him with wings and teeth. The jay retreated only to try again. This kept up for ten minutes until the jay left without doing visible harm to them.

SUMMARY

An estimated population of more than 150 northern red bats was observed at Lewis, Iowa, in 1939. This was an average of one bat per acre and one family per 4.5 acres; the average number of young red bats to a female was 2.3.

Families were most usually found in elm trees, and some remained regularly in the same roosts for weeks.

The first bats were noted on May 1, 1939, and the last on September 13, 1939. The peak of abundance was during the week of July 24. In the spring and fall a few hoary bats also were seen, and some of them reared young in the area.

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COMPARISON OF TRAPPING METHODS IN AN ILLINOIS PRAIRIE

By Clarence J. Goodnight and E. J. Koestner

Quantitative trapping methods using either live-traps or snap-traps have been in use for a long time, and their relative efficiencies are the subject of much discussion. The absence of any direct field comparison of these methods prompted the authors to carry out the trapping study reported here during 1939 and 1940 on an Illinois prairie renmant.

Blair (1940) made a study of the population and habits of the prairie deer mouse, and Burt (1940) studied the woodland deer mouse, employing live-trapping and marking methods. Previously many other studies had been made on small mammal populations in other areas. A number of the more important papers are mentioned by these authors, and Bole (1939) gives a summary and comparison of trapping methods.

The area selected was a stretch of prairie two miles west of Seymour, Champaign County, Illinois (R. 7 E., T. 19 N., Sec. 18) within a few hundred feet of the Champaign-Piatt County line. The area was located between the Illinois Central System tracks and State Routes 10 and 47. The prairie has been leased by the University of Illinois from the railroad, and is maintained in a relatively undisturbed condition. Although there is some burning on the area nearly every year, protected by fire-breaks, the plots were not burned in the period of of investigation. Since burning was a normal occurrence in original prairie, it probably does not constitute a serious modification here. The country is gently rolling and is covered with typical prairie vegetation; both high and low prairie was present in the area studied. In the low prairie, the more conspicuous plants were rosin weed (*Silphium terebinthinaceum*), compass plant (*S. lacinatum*), thistle (*Cirsium undulatum*), wild lettuce (*Lactuca canadensis*), flowering spurge (*Euphorbia corollata*), sunflower (*Helianthus hirsutus*), wild raisin (*Viburnum cassinoides*), *Franseria tomentosa*, golden rod (*Solidago speciosa*), white aster (*Aster paniculatus*), purple aster (*A. anomalus*), fleabane (*Erigeron annuus*), and willow (*Salix spp.*). The more conspicuous plants of the high prairie are the prairie violet (*Viola pedatifida*), shepherd's purse (*Capsella bursa-pastoris*), red clover (*Trifolium pratense*), hop clover (*T. procumbens*), strawberry (*Fragaria virginiana*), sorrel (*Rumex salicifolius*), false indigo (*Baptisia villosa* and *B. alba*), flowering spurge (*Euphorbia corollata*), golden rod (*Solidago speciosa*), wild lettuce (*Lactuca canadensis*), sunflower (*Helianthus tomentosus*), big blue stem (*Andropogon furcatus*), and blue grass (*Poa pratensis*).

Inasmuch as the trapping was done in winter, only the dried remains of the plants were present, but they furnished good cover to the small mammals present. Across the road and tracks were harvested cornfields, bordered in some places by hedges of osage orange (*Toxylon pomiferum*).

Two areas, 62½ meters long and 10 meters wide, were selected for the study. These areas were separated by a 37 meter buffer zone. Plot A was set with Sherman live-traps (see fig. 1) and Plot B was set with snap-traps in the same

manner. The traps were baited with a mixture of dry oatmeal and raisins. Each morning during the period of investigation, which extended from December 4 to 21 in 1939, and from December 6 to 22 in 1940, the traps were visited and

TABLE 1.—*Tabulation of all catches*[1]

		DECEMBER	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1939	PLOT A	Peromyscus maniculatus bairdii	-	-	-	1/0	0/1	0/1	0/1	0/1	0/1	-	0/1	0/1	0/1	0/1	-	-	-	-	
		Peromyscus leucopus noveboracensis	6/0	2/3	1/5	1/7	1/5	1/6	1/10	1/9	2/8	1/·	1/·	0/·	1/8	2/7	0/1	0/3	1/0	2/0	
		Microtus ochrogaster	6/0	1/3	0/5	0/3	0/2	0/1	-	1/2	0/2	0/1	0/·	·/·	0/2	0/3	-	-	-	-	
		Mus musculus	1/0	-	-	1/0	0/1	-	2/2	3/2	2/1	3/2	1/0	-	2/0	-	-	-	-	-	
		Blarina brevicauda	-	-	1/0	1/0	-	-	-	1/0	1/0		-	1/0	1/0	1/0	-	-	-	1/0	
		TOTAL	13/0	3/6	2/10	3/10	1/13	1/10	3/13	6/14	5/12	4/11	1/7	2/13	4/11	3/11	0/1	0/3	1/0	3/0	
		TOTAL	13	9	12	19	14	11	16	20	17	15	8	15	15	14	1	3	1	3	
	PLOT B	Peromyscus maniculatus bairdii	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Peromyscus leucopus noveboracensis	2	2	1	2[X]	-	-	2	1	2	-	1	-	-	-	-	-	-	-	
		Microtus ochrogaster	10	2	3	2	1[X]	-	1	2	-	-	-	1	1	-	-	-			
		Mus musculus	3	4	1	6	2	-	3	3	5	4	1	2	3						
		Blarina brevicauda	2	-	-	1	1	-	-	1	-	-	-	-	1						
		Cryptotis parva	-	-	-	-	1	-	-	-	-	-	-	-	1						
		TOTAL	18	8	5	11	5	0	6	7	7	4	2	3	6						
1940	PLOT A	Peromyscus maniculatus bairdii			1/0	3/0	1/0	0/1	0/1	0/61	0/1	0/2	1/1	0/2	0/3		0/1	1/0	0/1	-	-
		Peromyscus leucopus noveboracensis			2/0	4/2	2*/2	0/2	0/65	0/1	0/2	0/3	1/3	2/4	0/4	1/1	0/2	2/1	0/1	0/1	-
		Microtus ochrogaster			2/0	3/1	2/2	0/3	1/3	1/3	0/4	1/4	0/3	1/2	0/1	0/2	1/0	-	-	-	2/0
		Mus musculus			1/0	2/0	0/1	0/1	0/1	-	-	0/1	-	-	1/2	-	0/2	0/1	-	-	-
		Blarina brevicauda			1*/0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cryptotis parva			-	1*/0	-	1*/0	-	-	1*/0	-	-	-	-	-	-	-	-	-	1/0
		Synaptomys cooperi gossii			-	-	-	-	1*/0	-	-	-	-	-	-	-	-	-	-	-	-
		TOTAL			7/0	13/3	5/5	1/7	2/10	1/5	1/7	1/10	2/7	3/8	1/10	1/3	1/5	3/2	0/2	0/1	3/0
		TOTAL			7	16	10	8	12	6	8	11	9	11	11	4	6	5	2	1	3
	PLOT B	Peromyscus maniculatus bairdii											-	-	-	-	-	1	-	-	-
		Peromyscus leucopus noveboracensis											3[X]	-	-	-	-	-	-	-	-
		Microtus ochrogaster											5	4[XX]	5[XX]	-	1	2[X]	3[X]	1	-
		Mus musculus											-	-	3	-	-	-	1	-	-
		Blarina brevicauda											-	-	-	-	-	-	-	1	-
		Synaptomys cooperi gossii											-	1	-	-	-	-	1	1	-
		TOTAL											8	5	8	0	1	3	5	3	-

[1] Figures for Plot A above diagonal line indicate individuals caught for the first time; figures below the diagonal line indicate recatches. Data to the left of wavy line are for live-trapping, and those to the right are for snap-trapping. Each dot indicates one individual that died in the live-traps. Each x indicates one individual killed in Plot B, previously taken in Plot A.

the animals released or removed and recorded. Those in the live-traps were marked by the toe-marking method (Burt, 1940) so that they could be identified if taken again. Plot A was retrapped with snap-traps as a check on Plot B. This further provided a check on the live-trapping in Plot A.

The trapping data as compiled in Table 1 and summarized in Table 2 revealed that in general it took six to seven days to determine the population by the live-trapping method. Snap-traps gave the approximate total population in three days. The three day catch in Plot B is compared with the six to seven day results in Plot A in 1939. (Table 2). Likewise the retrapping of Plot A showed the same tendency in both years.

The most consistent results were obtained from the data on *Microtus* and *Peromyscus*, which apparently had small home ranges during the study. *Mus*

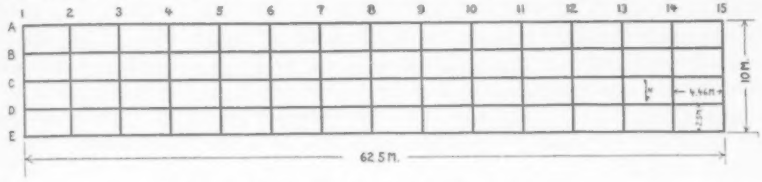

FIG. 1. Grid map showing location of traps

wandered more and shrews did not go in to the traps readily. In Plot A, after the approximate number of animals present was determined a few others were captured. These are considered wanderers extending their home ranges as most of them were caught on the periphery of the plot. Even so, the total number

TABLE 2.—*Comparison of cumulative totals*

	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13
1939	A live	13	16	18	27	28	29	32	38	43	47	48	50	54
	B snap	18	26	31	42	47	47	53	60	67	71	73	76	82
	A snap (corrected)	27	28	31	32	34								
1940	A live	7	20	25	26	28	29	30	31	33	36	37	38	
	B snap	8	13	21	21	22	25	30	33					
	A snap (corrected)	21	26	28	39	32								
Totals	A live	20	36	43	53	56	58	62	69	76	83	85	88	
	B snap	26	39	52	63	69	72	83	93					
	A snap (corrected)	48	54	59	71	66								

caught had more of a tendency to remain constant than in Plot B since the population being estimated was still present. Plot B having the animals killed by the snap-trap method was invaded by the new individuals after the area was trapped out. This is especially noticeable in the 1939 data.

Our experience was that the two methods of trapping were equally reliable for indicating the size of populations. Some recent workers employing the live-trap method have condemned the snap-trap method as a means of estimating mammal populations. Our results indicate that the two methods are comparable as far as population figures are concerned. In ecological studies involving year to year population changes, where large areas are used and the time available for trapping is an important factor, the snap-trap method can be used to advantage and the results probably will be reliable.

Table 2 shows the cumulative total on a comparative basis. The totals of

Plot A (live) represent the total number of different animals captured in the live traps. The figure under the first day is the number actually caught; under the second day, the number for the first day plus the number of new animals caught on the second day (not the total caught the second day), etc. The totals for Plot B (snap) under each day are the number of animals previously caught in the Plot plus the number caught that day. The corrected figure for the snap-trapping of Plot A were derived as follows: For the first day of snap-trapping the number of animals actually caught are added to the number that died previously in live-trapping the same plot. After the first day, the number of new animals caught each day is added to the preceding total. The basis for the corrected figures in this table can be found in Table 1, in which individuals that died in live-traps are indicated by a "dot", and individuals from the live-trapping area (Plot A) caught in Plot B are indicated by an "x". The areas used are too small for reliable population estimates for a unit area without making special allowances, but this does not affect the comparison of the methods.

The writers are grateful to Dr. V. E. Shelford, Chairman of the Committee on Natural and Uncultivated Lands for the University of Illinois, who kindly secured permission for us to carry on the trapping, and to Dr. S. C. Kendeigh, who offered helpful suggestions.

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GENERAL NOTES

AN EXTENSION OF THE RANGE OF THE TEXAS COTTON RAT IN KANSAS

On February 18, 1941, Mr. Fred Hastie collected two adult female Texas cotton rats, *Sigmodon hispidus texianus* (Audubon and Bachman), on his farm, seven and one-half miles southwest of Lawrence, Douglas County, Kansas. A third adult female was taken on March 2, and a fourth on April 1. All these, now numbers 13649–13652 inclusive, in the Kansas University Museum of Mammals, were found in corn shocks by Mr. Hastie when he was loading feed.

Black (Mammals of Kansas, 1935) gives the range of the Texas cotton rat in Kansas as "southeastern and south central Kansas north and west at least to Harvey, Greenwood, and Allen counties." Anthony (Field Book of North American Mammals, 1928) gives the northern limit of their range as Cairo, Pratt County, Kansas.

The area in which these specimens were taken has been trapped periodically by employees and students from the Kansas University Museum for more than thirty years, yet the Texas cotton rat has never been taken there during this period. Evidently this rat is moving northward in Kansas. The extent and cause of this movement is unknown at present. The last few years have been a period of higher mean temperature and decreased rainfall in this area, however. This, and other conditions resulting from it, might possibly allow an extension of the range of this species into areas where formerly a favorable habitat was not found.

I wish to thank Mr. C. D. Bunker, Curator of Birds and Mammals, Kansas University Museum of Birds and Mammals, for permission to report these specimens.—GEORGE C. RINKER, *Museum of Birds and Mammals, Lawrence, Kansas.*

NOTES ON THE ALLEGHENIAN LEAST WEASEL IN VIRGINIA

On November 14, 1940, upon returning from a collecting trip, I had just carried a load of equipment up the five flights of stairs to the wildlife laboratory and was unpacking a skin collection when my attention was attracted by a commotion suggesting a mouse in another part of the laboratory. Upon investigation I saw a small slender mammal dart across the floor in my direction. I recognized it to be an Alleghenian least weasel, *Mustela rixosa allegheniensis*, of which only one previous specimen had been taken in Virginia. Snatching a tablecloth from a nearby table, I dived under the table in the direction of the retreating weasel, but the agile creature was too quick for me and I straightened up, with only an unmistakable odor of *Mustela* clinging to a soiled tablecloth. The animal ran under another table and into some drawers. With the aid of a helper wearing leather gloves, the drawers were removed one at a time until the small carnivore was found crouching in a corner where this time it was unable to escape the gloved hand. Upon being picked up it bit the gloved hand and again emitted its "musk." When placed in a cage it fought viciously at a hand or finger placed near it, but fed at once on the body of a bird that was placed in the cage. Unfortunately, however, the animal apparently had been injured, as it died after being kept in captivity for about 18 hours. The dead specimen was made into a study skin.

In checking the literature, I have found that some least weasels have been taken in or near old buildings but no record seems so unusual as this case. There is little doubt but that this mustelid was in the building in search of house mice and had worked its way to the fifth floor in runways used by rats. The particularly ironic part, however, seems to be in the fact that it came to the wildlife laboratory in the biology building where it was almost certain to become a martyr to science!

On January 14, another specimen was brought in that had been taken near one of the dormitories of the Virginia Polytechnic Institute. This one was seen darting its head in and out of a hole at the corner of the building in apparent curiosity. It was finally poked out of the hole, captured and brought into the wildlife laboratory, where it was kept in captivity for several days. During this time it was fed on house mice and observations

were made on its habits. When a live mouse was placed in the cage, the weasel sprang upon it almost instantly. Grasping the mouse by the back of the head, the weasel bit its victim through the skull several times in rapid succession and held on with its sharp teeth. The sound of the teeth piercing the bone was distinctly audible at a distance of several feet. During this interval the weasel hugged the mouse closely with its fore legs and pre sed it firmly to its belly through a kicking motion of the hind legs. The hold on the back of the head was not relinquished until the mouse was dead. The killing took only a few seconds. Upon releasing the mouse the weasel usually came to the front of the cage and inspected the observer for an interval of several seconds after which it returned to its prey and began its meal at once. Sometimes the blood would be licked from the wound in the back of the head or perhaps an ear would be chewed a bit and the blood licked off, but never did the weasel "cut the throat" of its prey and "suck the blood."

The weasel ate the head and brain first, beginning at the back of the head and working forward. Just before reaching the nose the process was reversed and eating then pro-

TABLE 1.—*Data on Specimens of Mustela rixosa allegheniensis (Rhoads) taken in Virginia*

LOCALITY	COLLECTOR	DATE	COLLECTION	SEX	WT.	TOTAL LENGTH	TAIL LENGTH	HIND FOOT	EAR
					gms				
Blacksburg, Montgomery Co.	Clyde P. Patton	Oct. 31, 1936	U. S. N. M. No. 261851	♂		282.	9 27.4	22.9	
Blacksburg, Montgomery Co.	L. M. Llewellyn	Nov. 14, 1940	Va. Coop. Wildlife Unit L. L. No. 752	♂	34.5	195	35	22	15
Blacksburg, Montgomery Co.	L. M. Llewellyn	Jan. 1, 1941	Va. Coop. Wildlife Unit L. L. No. 792	♀	24.9	175	26	18	12
Near Dayton, Rockingham Co.	D. H. Shaver	Jan. 20, 1941	Va. Coop. Wildlife Unit L. L. No. 794	♂	63.5	217	42	25	12

ceeded from the base of the skull toward the tail of the mouse. The tip of the nose, maxilla with teeth, and the tail seemed to be the parts least preferred; they were not eaten when an abundance of food was present. At no time did the weasel place its front feet on the mouse in an attempt to hold it. A second or third mouse was killed immediately upon being placed in the cage even though the first one had not been consumed. The weasel, however, usually returned to the partially eaten mouse and finished it before starting on a new one. Upon completing a meal, especially if the meal had been particularly bloody, the weasel rubbed its chin on the bottom of the cage, scooting along and appearing more snake-like than normal. Whenever I attempted to remove a mouse, or partially eaten one, from the cage, the weasel hung to the mouse tenaciously, and often allowed itself to be lifted up in this manner.

In the six days that the weasel was kept in captivity it was fed 10 house mice having a total weight of 118 grams. As no food was given on one day, the amount of food eaten is probably slightly below the actual capacity of the animal. Since the weasel weighed only about 32 grams, the average amount of food eaten a day was slightly in excess of one-half

the weight of the animal. Judging from this observation and from the animal's lust for killing, one can imagine the large number of rodents that one of these animals might destroy in the course of a year.

An idea of the quickness and accuracy of this tiny weasel was gained when a mouse held in a pair of long forceps was swung back and forth across the cage (pendulum fashion) with a quick motion of the holder's wrist. The weasel almost invariably jumped and caught the mouse as it passed rapidly by, and hung on until it jerked it free from the forceps.

The viciousness and aggressiveness of the weasel was further illustrated by the fact that it was always ready to leave its meal and dart to the front of its cage when a finger or pair of forceps was placed on or near the screen. As the weasel darted toward the annoying object and then sprang away, the motion was so quick that it could scarcely be followed with the eye. At this time it usually uttered a high shrill shriek, and, if teased for several minutes, a small amount of musk was often thrown off.

On January 20, 1941, another specimen was obtained by D. H. Shaver near Dayton, Rockingham County, Virginia. A subsequent specimen was reported from the same locality by Mr. Shaver in February but, unfortunately, it was not saved.

The first specimen obtained in Virginia was taken by Clyde P. Patton on October 10, 1936, at Blacksburg, Montgomery County, within one mile of the point where the two other specimens mentioned in this paper were taken. Patton's specimen was found in a "post hole" trap after he had noticed that field mice, which had fallen into the hole, had been killed and partly eaten. This specimen was deposited in the U. S. National Museum (Biological Surveys collection). Another individual was also observed by Patton in the same locality in April 1937.

All specimens seen or observed have been in brown pelage. The color of the specimen taken on November 14, 1940, is a rich walnut except for the white on the throat, chin, and a small patch of white in the inguinal region. The white on the throat extends up on the sides of the throat even with, but slightly back of, the notch of the ear. The fingers are tipped with white both above and below and the white from the throat extends out onto the forelegs covering about one-third of them. The mid-portion of the belly has a sprinkling of white hairs and a few white hairs are in the sides and flanks. Other specimens correspond closely to this with the exception of a slight variation in the amount of white.—Leonard M. Llewellyn, *Virginia Cooperative Wildlife Research Unit, Blacksburg, Va.*

A METAL RESTRAINING TUBE FOR ANIMALS

In measuring the "attrition and extrusive growth of incisors" (Shadle 1936) of Canadian porcupines (*Erethizon dorsatum dorsatum*), it was impractical to use the zippered tube holder (Shadle and Skarupinski 1935), which was used so successfully for other animals. Because porcupine quills penetrate cloth, leather and other such materials, the protruding spines make it impossible, even with heavy gloves, to handle a sack or flexible tube without the operator being injured by the spines. When the free ends of the quills have penetrated some tough substance they are readily dislodged from the porcupine and, with frequent handling, this great loss of spines from the animal's pelage is undesirable.

If placed in a metal container and anaesthetized, a porcupine can easily be handled, but there are two objections to this procedure; (a) the necessity, and the difficulty, of keeping the animal anaesthetized while working on the teeth, and (b) weekly anaesthetizing is undesirable because of possible effects on the normal rate of "attrition and extrusive growth of the incisors."

In an effort to restrict the movements of the animal, and to protect the operators from the spines or quills of the porcupines, there was developed an adjustable metal container, which eliminates the defects of the soft zippered tube and makes available an apparatus for use with other animals. We have found it quite satisfactory both for porcupines and beaver and anticipate using it for woodchucks.

This apparatus consists of a 28 gauge, galvanized iron tube, 36″ long, with a truncate

cone at the lower end. The piston can be pushed in and locked with an iron bar, thus reducing the space in the tube, and crowding the animal into the desired position. When the tube is suspended by the large end, the smooth inner surface gives the animal no foothold against which to push or cling, and gravity forces it to the bottom. The bottom opening is large enough for the animal's head or tail region to protrude.

The tube (A) consists of a cylinder 26″ in diameter, to which is joined a truncate cone 10″ long, with a 4½″ opening (a) at the lower end. Two ¼″ round head bolts 5½″ long through the openings in two pairs of ears (b) prevent the smaller animals from crowding through the opening (a) before the operator is ready for them. These bolts are fitted with wing nuts to facilitate their insertion or removal, depending upon the size of the animal being handled. To protect the animals and to strengthen the tube, each end is reinforced by a heavy wire which is rolled into its edge. Two additional ears (c) are points of attachment for the snaps and rope with which the container may be suspended from a pulley in the ceiling. On opposite sides, two inches from the edge of the large end of the tube, are bushings (g), with holes $\frac{7}{16}$″ in diameter through which passes a ⅜″ iron rod (h) 15″ long. The breast plate (k) enables one to push the piston down while freeing hands to hold the tube.

The 30″ piston (B) consists of a pan-shaped metal head (d) with a 1½″ square wooden shaft (e). The piston head is supported by the shaft and four quadrangular wing-braces

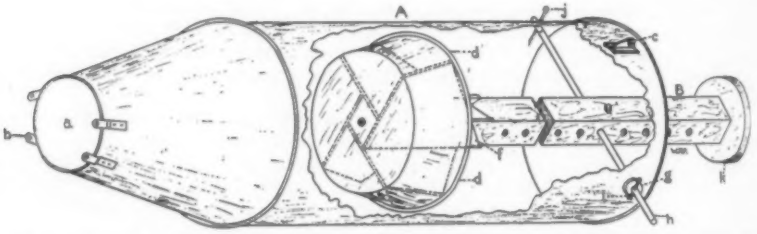

FIG. 1. A metal restraining tube for animals (A) the tube, (B) piston, (a) opening, (b) ears which hold two roundhead bolts across opening, (c) ears by which tube may be suspended from ceiling by rope and pulley, (d) metal head of piston, (e) piston shaft, (f) quadrangular brace, (g) bushing, (h) iron locking rod, (i) permanent cotterpin, (j) removable cotterpin, (k) breast plate.

(f) attached to it. A series of $\frac{7}{16}$″ holes, one inch from center to center, make possible piston adjustment to a wide variation in sizes of animals.

In making this type of apparatus, the diameter of the tube should not be large enough for the animal to reverse its position. The large end of the tube is forced over the animal from head toward tail, and the piston is then inserted and pushed forward far enough to crowd the porcupine (or other animal) into the smaller end, with its head protruding from the hole in the cone. The iron bar is then run through the bushing (g) on one side, through the nearest hole in the piston shaft (e), and through the bushing on the opposite side, thus locking the piston in any desired position. A permanent cotterpin (i) and, in the opposite end of the bar, a removable cotterpin (j) facilitate the locking, or the complete removal of the bar as desired. The breastplate enables the operator to push the piston into position and at the same time frees both hands for the locking manipulations.

By protecting the operator from the quills of the body and the lashing tail, the porcupine becomes relatively harmless. In the holder, the animal may be kept for the desired length of time to weigh it, to examine, mark, and measure the teeth, and if necessary, to administer medicines.

In experiments with a porcupine, by reversing the procedure and putting the animal tail first into the tube, rectal temperatures were taken. This operation was impossible as long as the animal was free to strike with its tail.

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AN OS CLITORIDIS FROM APLODONTIA

So far as we have been able to learn, the only mammals possessing a true *os clitoridis* are members of the genera *Lutra*, *Cryptomys*, and *Aplodontia*. The bone doubtless occurs also in other genera where, because of its diminutive size, it has been overlooked by students of gross anatomy. C. A. Hubbard (The Murrelet, vol. 3, pp. 14–18, 1922) states that the clitoris of *Aplodontia rufa* "consists of a gristle-like, slender bone situated in the lining of the vagina very close to the external opening. The organ is stiff so not erectile."

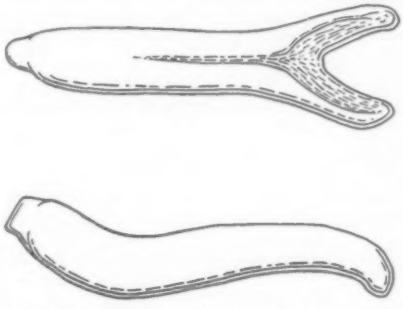

FIG. 1. *Os clitoridis* of *Aplodontia rufa rufa;* anterior (proximal) end at right; enlarged 10 diameters; V. B. S. no. 832.

We dissected the clitoris from a female mountain beaver collected near Redmond, Washington, on March 21, 1940, and placed it in a culture of dermestid beetles. The *os clitoridis* was soon exposed as a forked or spoon-shaped bone six millimeters long and two millimeters in greatest width (fig. 1). It was dense and opaque; a true bone rather than gristle.—VICTOR B. SCHEFFER, *Fish and Wildlife Service, Seattle, Washington.*

A PERSISTENT WEASEL

On August 12, 1941, I heard a commotion in my yard at Lake James, Indiana. I investigated and found that a New York Weasel was after a young rabbit.

They passed by me several times in their mad rush back and forth. I tried to frighten the weasel, but it paid no attention to me. Judging by the squeals of the rabbit, the weasel had wounded it several times, apparently in the throat. At last the rabbit gave in. As I came close, the weasel let go of the rabbit, but would not go far away. It kept returning, again and again, and tried several times to drag the rabbit away from in front of me. It ran over my shoe two or three times; I even put my finger on the animal. It was not afraid and apparently had no intention of losing its prey. The weasel had made five large holes in the rabbit's throat, but there was no obvious bleeding.

After the rabbit was killed, the weasel still remained and was so engrossed that we placed half a minnow trap over him and the dead rabbit. We then shoved a pane of glass under the trap, turned all over, and fitted the other half of the trap into place. The weasel and the dead rabbit were immersed in the lake until the weasel drowned. Its skin is now in the Field Museum of Natural History.—MARY S. GROSJEAN, *Lake James, Angola, Indiana.*

NOTES ON THE WINTER FOOD OF BEAVERS IN THE PALOUSE PRAIRIES, WASHINGTON

This paper is based upon observations made in the winters of 1939–40 and 1940–41 on the south fork of the Palouse River and its tributaries. Intensive study was made of an isolated colony, estimated to contain seven beavers, on Paradise Creek, about two and

TABLE 1.—*Food plants of the beaver*

SPECIES	PORTION EATEN	PER CENT OF DIET[1]
Populus tremuloides	Bark and twigs	50
Salix sp.	Bark and twigs	15
Typha latifolia	Root-stalks and shoots	25
Crataegus Douglassi	Bark	
Gramineae	Blades	10
Miscellaneous plants		

[1] Estimated per cents of food eaten by the Paradise Creek colony of beaver during the winter of 1939–40.

TABLE 2.—*The number of aspen and the volumes of each class of tree cut by seven beavers*

DIAMETER IN INCHES	NO. OF TREES LEFT IN GROVE	NO. OF TREES CUT	VOL. CUT IN CU. FT.	CONVERSION FACTOR[1]	CORDS CUT
1	—	—	—	—	—
2	50	—	—	—	—
3	37	2	1.1	54	0.02
4	48	2	2.8	57	0.05
5	34	4	11.8	61	0.19
6	32	4	16.8	64	0.26
7	46	8	48.8	69	0.72
8	36	6	51.0	71	0.72
9	22	4	45.6	74	0.61
10	15	—	—	76	—
11	13	—	—	78	—
12	3	—	—	79	—
13	3	1	25.6	80	0.32
Totals	339	31	203.5		2.79

[1] The figures in Table 2 are based upon yield tables by Brown and Gevorkiantz (1934). These tables give the total volume of wood, including bark, in cubic feet. The figures for cubic feet are then converted to cords which are more usable. By converting cubic feet to cords the fact that a higher percent of the total absolute volume of smaller material is available for food is counter-balanced by a cord of the larger material containing a larger net volume of material than the smaller material (see conversion factors in Table 2). The conversion factors are given for each diameter class of aspen. The volumes listed include all materials cut even though some portions are occasionally wasted.

one-half miles east of Pullman, Washington. The colony was removed early the second winter, so it was not possible to obtain two year's data on cutting for the winter food supply.

The area is mainly a grain growing section and the only brush and trees are found along the small streams. The dominant plants that are available for winter feeding are *Crataegus* sp., *Salix* sp., *Populus tremuloides*, *Rosa* sp., *Symphoricarpos* sp., *Typha latifolia*, and seve-

ral species of grasses. Of these the aspen, willow, and cat-tail are the only ones that form a staple part of the beavers' diet. The haw was cut occasionally, but though it was by far the most abundant tree, its bark was not an important part of their diet. The portions of these plants used by the beaver and their importance in the animal's diet are indicated in Table 1.

Measurements of all woody material cut were taken and the volume of wood computed to cords (Brown and Gevorkiantz, 1934). The proportions of the other foods were estimated in relation to the amount of material suitable for food. The number of trees cut by these seven beaver, the size classes chosen in relation to the trees standing, and the number of cords are shown in Table 2.

The aspen and willow were worked on almost exclusively until the first freezing weather came. After this the food was aspen and willow from the stock pile supplemented by large quantities of cat-tail root stocks that were dug from the mud under the ice. While the food was often taken to the main den to be eaten, it was more often taken to a short secondary den. This was especially true if the food was the root stalks of the cat-tail.

There was no sign of any cutting of the woody species after the first scum of ice formed over the ponds. The beavers broke through the ice and came out on the bank, but seldom went over five or six feet from where they broke through.

It was found that each beaver cut about 0.40 cords of aspen plus about 0.12 cords of willow, a total of 0.52 cords for the winter. This amount comprises 65 percent of the winter food. If the woody species were used exclusively, about 0.8 cords would be required to supply the required amount of bark.

LITERATURE CITED

BROWN, R. M. AND S. R. GEVORKIANTZ. 1934. Volume, yield, and stand tables for tree species in the lake states. Minnesota Agric. Ex. Sta. Tech. Bull. no. 39.

JAMES BEER, *Montana Department of Fish and Game, Helena, Montana.*

A SINGING MOUSE

The reactions of a singing house mouse to man-made music were observed for a 10-day period in March, 1940, in which time the mouse had established itself in a radio cabinet at my home in San Francisco. The mouse's voice was first noticed about a week after a swarm of mice invaded the apartment, probably attracted by seeds placed on the window sills for birds. By the end of that week the hiding places of the mice were known, the radio being the favorite of many.

It was suspected that one animal was a singing mouse after I failed in an attempt to tune out a melody that persisted during the pauses in a musical program. When the song continued no matter where the dial was turned, it was obvious that the tune did not arrive over the air. Also, close listening proved that the song came from the upper compartment of the radio, containing the tubes, instead of from the loud speaker three feet lower down. Later investigation showed only a small amount of droppings in this upper compartment. The quantity on the floor under the cabinet, and the fact that the rug there was thoroughly chewed, indicated that most of the mice in the radio hid in the space at the bottom. Perhaps only the singing mouse occupied the tube compartment. There were no evidences of nest-building in the radio cabinet, although nests were found elsewhere in the room.

The mouse was never heard except when music had been coming through the radio—never, that is, when the radio had been turned off for some time, nor during a drama or prolonged talk. Its relatively faint song was heard a few times *with* the radio music, and that it often accompanied the music, undetected, was suggested by the way its voice would carry on without a break when a selection came to an end. It generally sang straight through the announcer's interludes. When the radio finally was turned off the mouse's singing might continue for as long as three minutes. It once sang through every announcement in a full hour's program.

The song never was heard earlier than 5 p.m. However, it may have occurred in the day and have been confused with the voices of 30 to 40 linnets that spent their time nearby and on the window sills. The song never was heard after the radio and lights were turned off for the night, when the mice came out to forage.

The mouse's voice was clearly audible in an adjoining room 15 feet from the radio. Its song resembled a canary's but there were differences. The range seemed shorter, reaching notes neither so high nor so low as in the song of the average canary. There were fewer trills and grace notes. About eight notes seemed to comprise the mouse's principal melody but generally these were somewhat embellished.

The mouse's song was not quite so sure as a canary's; it lacked the bird's bold, showy attack. Also it lacked the canary's almost metallic brilliance. The tones were warmer, more obviously coming from a throat of flesh. The song had a poignant quality, in its small way.—SALLY CARRIGHAR, *Room 302, 628 Montgomery Street, San Francisco, California.*

OBSERVATIONS ON THE SHORT-TAILED WEASEL IN CALIFORNIA

While camping at Woods Lake (altitude 10,860 feet) in the back country of the Kings Canyon National Park, Fresno County, California, the writer found a den of short-tailed weasels (*Mustela cicognanii lepta* (Merriam)) under the partially dead, hollow roots and trunk of a large fox-tail pine about 100 yards south of the margin of the lake. The presence of weasels in the vicinity was suspected before they were seen because of the occasional excited chirping of white-crowned sparrows (*Zonotrichia leucophrys*) in the near-by willow thickets. On August 5, 1941, a weasel was first seen in a willow clump near the camp as it was being pursued by two white-crowned sparrows. It ran under some large rocks at the water's edge and was quickly surrounded by four members of our party. In the next 15 minutes several photographic exposures were made as the animal climbed about the rocks looking for means of escape.

A white-footed mouse (*Peromyscus* sp.) that had been killed several hours before was secured under one of the heavy rocks with only the foreparts exposed. The weasel pulled the dead mouse free while the observer was less than two feet away. Thereafter in looking for a means of escape the weasel sometimes appeared with the mouse which it held just back of the shoulders. When our group retired a few feet, the weasel, after careful reconnoitering, returned for the mouse and began running at a surprising rate of speed through the willow clumps, and using all other available cover, to its den 286 yards away.

At 10:30 a.m. the next day, a weasel was seen returning to the den with a short-tailed mouse (presumably *Microtus* or *Phenacomys*) held in the same manner as was the *Peromyscus*. The weasel stopped, looked momentarily at the observer who was less than five feet away, and entered the den. It might have remained longer had not a Clark nutcracker (*Nucifraga columbiana*) dived threateningly toward it from a near-by pine.

The hole that the animal entered under the tree was scarcely an inch high and three inches wide. About ten minutes later a full grown weasel peeked out. No weasels were seen again until 2:30 p.m. when one came out but was frightened back by the noise of the camera shutter. Almost immediately a young weasel, scarcely as large as a house mouse (*Mus musculus*), came out of the hole, sniffed the air, and slowly crawled in again. Its short black-tipped tail was scarcely one-half inch long. Twenty minutes later an adult weasel emerged from another small hole in a hollow exposed root nine feet away from the hole first discovered. It reentered this hole and no more activity was observed up to 7 p.m. A small pine cone was placed before each entrance when the observer left.

The next day (August 7) before 6:50 a.m., both cones were moved out of the entrances. The cones were replaced and were removed again before 8:15 a.m. when the observer was absent. At 8:30 a.m. a weasel came to the den with a half-grown mouse (presumably *Microtus* or *Phenacomys*) and entered the small hole in the hollow root. A few seconds later, scratching could be heard and a weasel was seen through a crack in a large root. At the same time similar scratchings could be heard in the hollow part of the trunk of the tree.

No more activity was noted before 11 a.m. when the observer was driven to camp by a storm. Upon his return at 12:30 p.m., the cones with which he had plugged both entrances

PLATE 1

Upper: A mature short-tailed weasel looking from its den
Lower: A short-tailed weasel carrying a white-footed mouse (*Peromyscus* sp.)

to the den had been removed. At 2:20 p.m. a weasel left the den by the earth entrance. A weasel returned again at 3:55 p.m. carrying a large *Peromyscus* sp., which it attempted to

which of necessity must hoard greater stores over a longer period. Examination of these pouches should be made by field collectors, for the contents often give a clue to the type of food that is eaten. I have removed 13 seeds of the jewel weed (*Impatiens biflora*) from the pouches of a deer mouse.—W. J. Hamilton, Jr., *Cornell University, Ithaca, New York.*

COYOTE WITHOUT EXTERNAL EARS

In the autumn of 1941 agent Robert W. Sears, of the Fish and Wildlife Service, with headquarters at Maybell, Colorado, collected some 300 coyotes, of which one was a pup without external ears. He writes that "they were partly formed under the skin of the head but had never broken to the outside."—Clarence Cottam, *U. S. Fish and Wildlife Service, Washington, D. C.*

ARMADILLO EATS YOUNG RABBITS

The food of the Texas nine-banded armadillo (*Dasypus novemcinctus texanus*) is generally thought to consist of insects, other invertebrates, and some plants; the following observation indicates, however, that their food may include also mammals.

On August 29, 1941, the writers were at the camp house of the Piney Creek Deer and Turkey Project, nine miles north of Camden, Polk County, Texas. About 9 o'clock in the evening a shuffling noise was heard under the house. Presently the animal making the sound moved out from the house about 20 feet to a small shrub. Almost immediately squeaking sounds were heard. On investigation, the writers found an armadillo eating a young cottontail rabbit (*Sylvilagus floridanus alacer*). Finishing this rabbit, the armadillo began on a second one that was lying nearby. The manner of eating was similar to that of a hog, except that more time was spent in chewing. The armadillo's teeth apparently had little effect, but by continued chewing the food was softened. Small portions were then pulled off as the armadillo's front feet held the food on the ground. Evidently pieces an inch or so in diameter were too large to be swallowed.

While consuming the two rabbits, the armadillo paid little attention to the beam of a flash light held within a foot of its head. Likewise, it did not appear disturbed by conversation. The armadillo was prodded twice with the flash light. It sat up on its hind legs in a defensive position, but, as it was not again disturbed, it proceeded to continue its feast.

Further observations revealed an uprooted grass nest, with another dead young rabbit inside it. The rabbits were all about four inches in length with their eyes not yet open. The fact that the nest was torn up and the dead rabbits severely skinned and broken suggested that the armadillo had dug into the nest and had killed the victims with blows of its heavy front feet.

During our observations the armadillo finished eating the three rabbits. It took about five minutes to complete the meal.—Coleman C. Newman and Rollin H. Baker, *Texas Game, Fish and Oyster Commission, Lufkin, Texas.*

SYNAPTOMYS COOPERI IN FORESTED REGIONS

The note by W. J. Hamilton in the Journal of Mammalogy, vol. 22, no. 2, on the occurrence of *Synaptomys* in forested regions suggests that additional data on this subject may be worth recording. I have pertinent records from the region of Lake Temagami and from Algonquin Park, both in the District of Nipissing, Ontario.

The Temagami area is virgin Laurentian pine forest with practically no clearings, the only open spaces being bogs and a few bare, rocky ridges. Algonquin Park was originally of the same character, but has been cut over, and the present forest is largely second growth maple-birch-hemlock, interspersed with numerous grass-grown clearings.

From Temagami I have 22 records, 11 males, 10 females, and one of unrecorded sex: 6 males and 4 females were taken in dry woods, mainly red and white pine with a sprinkling of other trees, and with ground cover that ranged from fairly dense to sparse; 1 male and 3 females came from dense black spruce-sphagnum stands; and 4 males, 3 females, and the unsexed specimen came from more open boggy tracts, chiefly among sphagnum under *Nemopanthus* and *Alnus* in the transition zone from open bog to forest.

From Algonquin Park I have records of 10 males and 3 females: 6 males and 1 female were caught in woods of the prevailing type, the ground being covered by a thick mat of dead leaves and further protected by abundant maple seedlings up to 3 or 4 years old; 3 males and 1 female were taken in black spruce-sphagnum stands; and one of each sex was captured on an exposed, dry hilltop among grass and bracken.

Thus, of 35 specimens of *Synaptomys*, 25 were taken in the forest. I was, indeed, surprised to learn that this occurrence had any special interest, since, during the 10 summers in which I have trapped in the Temagami area, I have come to expect *Synaptomys* anywhere, although it never has been common. It may be recalled in this connection that W. E. Saunders (Notes on the Mammals of Ontario, Trans. Royal Can. Inst., vol. 18, pt. 2, 1932) remarks "In the north country one finds them almost everywhere"; a view with which I agree.—A. F. COVENTRY, *University of Toronto, Ontario.*

ABNORMAL COLORATION IN THE PRAIRIE MOLE

On May 18, 1941, a male albino Prairie Mole, *Scalopus aquaticus machrinus* (Rafinesque) was dug up near Colp, Williamson County, Illinois, by Floyd Hogg, a student of Herrin Township High School. Norman A. Meinkoth brought the mole to the museum. Its pelage is almost pure white ventrally, except for a tendency toward yellow-orange tones about the anterior half and a concentration of this color on the mid-ventral line from the anterior end of the sternum to about the middle of the abdomen.

This specimen is deposited in the museum of the Southern Illinois Normal University, Carbondale, Illinois.—E. LENDELL COCKRUM, *S.I.N.U. Museum*, and NORMAN A. MEINKOTH, *Department of Zoology, University of Illinois, Champaign, Ill.*

POCKET MICE IN CRATER LAKE NATIONAL PARK

This is to record the presence of the pocket mouse, *Perognathus parvus*, in Crater Lake National Park. On July 31, 1941, two specimens were taken along the western edge of Wheeler Creek Canyon at the 5,500 foot level. Both were lactating females and both in an early stage of pregnancy. One contained four and the other six embryos.

The measurements of the larger were: Total length, 155.0; tail, 85.0; hind foot, 22.5; ear, 8.2 mm. These dimensions are smaller than those published by Bailey (N. Amer. Fauna, no. 55, p. 247, 1936) as representative of Coues's Pocket Mouse, *P. p. mollipilosus*, of the Upper Klamath Lake area.

Common plants of this area of Crater Lake National Park are the lodgepole pine (*Pinus murrayana*), waxy current (*Ribes cereum*), and Bloomer's rabbit brush (*Chrysothamnus bloomeri*). The soil is a powdery pumice.—R. R. HUESTIS, *Crater Lake National Park, Oregon.*

REVIEWS

Poole, Arthur J. and Schantz, Viola S. CATALOG OF THE TYPE SPECIMENS OF MAMMALS IN THE UNITED STATES NATIONAL MUSEUM, INCLUDING THE BIOLOGICAL SURVEYS COLLECTION. Bulletin 178 U. S. Nat. Mus., pp. I–XIII, 1–705. 1942. Price $1.25 (Supt. Documents).

The list of mammalian types in the U. S. National Museum which was published in 1909 is here brought down to date in a thick volume, showing much evidence of conscientious care in preparation. Like its predecessor, it distinguishes types received through the Biological Survey or Fish and Wildlife Service and those from other sources. It is interesting to note that while those of the Biolgocial Survey constituted more than half the total in 1909 (713 out of 1405) they now number less than half (1326 out of 2824). The gain in total number of types is 1419, from 1405 in 1909 to 2824 in 1942, truly an enormous increase doubtless not even approached in any other institution. Various interesting, but perhaps not especially significant inferences can be drawn from these figures. The average annual increment in types is about 45 divided between the National Museum proper and the Biological Survey in the proportion of 5 to 4. A rather hasty and probably inaccurate count of synonyms reveals that 243 types or about 9 percent represent names either unnecessary or so regarded in some quarters. The proportion of these that are recent has not been checked but is perhaps not large. Every order of mammals except Monotremata, Proboscidea, and Sirenia is represented and nearly every zoogeographic province. From Australia, however, not even a single type is included. Rodent types number 1595 or more than half the total, carnivores made a poor second with 370, followed by bats with 231, and insectivores with 221. These four orders, therefore, include about 85 percent of all the types.

The names of the types are entered as originally proposed with full citations followed by indication of nomenclatural changes and present status with authorities. Thus a considerable amount of valuable bibliographic data is presented. An innovation in arrangement is the wholly alphabetic sequence not only of genera and species, but also of orders and families. Except in the case of species and subspecies, this seems to have little practical advantage in lessening the use of the index, but it avoids the choice of an ephemeral classification. Appended is a list of missing types (only 23), a geographic concordance, and a list of collectors (491).

The book shows every indication of thoroughness and accuracy and is a credit to its authors.—WILFRED H. OSGOOD.

Elton, Charles. VOLES, MICE AND LEMMINGS, pp. 1–496, 21 figs., frontispiece, Clarendon Press, Oxford, 1942. Price $10.00.

Fluctuations of animal populations have long attracted the attention of man, but no serious inquiry into the underlying principles and causes of such phenomena was undertaken until two or three decades ago. The present compendium, written by a pioneer in this branch of ecology, therefore, is indeed a timely contribution.

The volume comprises four parts: (1) Vole and mouse plagues—an historical resumé of recorded plagues round the world; (2) fluctuations in northwestern Europe, with emphasis on wildlife cycles in Scotland and the Scandinavian Peninsula; (3) wildlife cycles in Labrador; and (4) wildlife cycles in Ungava. Chapters eight and nine, part two, are especially instructive as therein are discussed the methods of population analyses developed by Elton and his coworkers, methods that have been utilized and modified by American workers.

Violent fluctuations in numbers of rats, mice, rabbits, and grouse are better known than in some other animals, since the high reproductive potential in such forms reduces the interval between peaks to from 3 to 10 years, making the "plagues" more conspicuous by their frequency, but fluctuations are by no means confined to such prolific breeders and their natural predators, as the bulk of literature on population dynamics might lead one to think. Violent fluctuations also are known in such slower breeding species as caribou, deer, pronghorn antelope, hippopotamus, zebra, and others. The long lapse of time between peaks, however, obscures their severity and rhythm. In the "hill country" of Texas, for example,

the older residents maintain that a "die-off" of deer in large numbers occurs about every 20 to 25 years, hence from two to three times in the average life span of man.

The causes of fluctuations are not well understood, nor does Elton discuss this phase of the problem as well as the reviewer desired. Disease and dispersal in herbivores and lack of food in predators appear to be important reducing agencies; reproductive potential catapults the population upward when conditions are favorable.

The reviewer regrets that the author did not devote a chapter to summarizing the mechanics of population cycles, even though he may not have been in a position to give all the answers, for such a summary would have enhanced the value of the contribution. A fairly clear picture of events is depicted, however, in the case of the lemming in Ungava in the chapter titled "The Downfall," but the reader must extract all such information in other instances from the voluminous data that are here assembled. This, to the reviewer, is the chief weakness in this work. Even so, the volume is a mine of information, well written, and brings together for the first time a voluminous literature on the subject. The author deserves the commendation of all students of population dynamics for the painstaking efforts that have been devoted to the compilation and publication of this volume. It constitutes the foundation on which future craftsmen can build a more nearly complete picture.—WILLIAM B. DAVIS.

Walls, Gordon Lynn. THE VERTEBRATE EYE AND ITS ADAPTIVE RADIATION. Cranbrook Institute of Science, Bull. no. 19, xiv, 785 pp., 197 figs. 1942. $6.50 (cloth).

For years morphology has been vilified as "antediluvian," "archaic," "obsolete," or just plain "dead" by many of the bright young men who are noisily busy skimming off the easy and obvious research problems in more recently opened fields. Perhaps, therefore, a morphologist may be permitted to emerge from his mummy case long enough to smile in anticipation of the rousing reception this book is sure to get from ecologists, animal behaviorists, and other non-morphologists.

The Vertebrate Eye is far more than a book for ophthalmologists, or even for morphologists—it is a "must" book for every biologist, whatever his specialty. Those biologists whose knowledge of the eye has more or less perforce been limited to the figures and descriptions familiar in text-books, and whose interest in the eye has been tempered accordingly, are due for a pleasant shock when they first make the acquaintance of this handsome volume. For here the eye is presented, not as a complex optical instrument that happens to be a part of the vertebrate body, but as a vital, plastic part of the equipment with which each animal plays the game of life. Those of us who long awaited Dr. Walls' "book on the eye" hardly anticipated the genuinely fascinating nature of the author's treatment, or the extraordinarily broad applications that the subject has assumed in his hands. The years of careful work that went into the preparation of this volume are reflected on every page.

The author has divided his subject into three main sections, which bear the titles *Basic*, *Ecologic*, and *Synoptic*, respectively. The "basic" section presents the necessary fundamentals of the structure, functioning, and origin of the vertebrate eye in simple language, illustrated with extremely carefully planned drawings and diagrams. The human eye is used as an example of a typical vertebrate eye; the usually formidable subject of the optics of the eye is treated along with its morphology. A separate section is devoted to that wondrously complex mechanism, the vertebrate retina. The preface states that the author assumes "no more scientific knowledge on the reader's part that the contents of the usual elementary course in biology," and it is a rare pleasure to record that this is literally true. The final "synoptic" section presents a brief review of the eye in each of the vertebrate classes. The bearing of the morphology of the eye upon problems of vertebrate phylogeny is emphasized in this section, and the rich possibilities in this field will be a revelation to most readers. Some will doubtless object to the far-reaching conclusions Walls has drawn from his ophthalmological data, but few will be able to offer more convincing and more carefully worked-out counter arguments.

The "ecologic" section accounts for nearly two-thirds of the bulk of the book. It is in this fascinating section that the author has abandoned the classical comparative approach

to his subject. Most morphologists are so steeped in the Gegenbaurian *progressive* evolution—the familiar fish-to-man hierarchy of many a course in comparative anatomy—that they are blind to the fact that this is only one of several morphological approaches to this most complex of all problems. The question of *adaptive* evolution is just as pregnant with possibilities as was that of progressive evolution. Actually it represents the reverse of the Gegenbaurian approach, for here phylogeny assumes the same secondary importance that adaptation does in the Gegenbaurian system. Progressive evolution was useful in demonstrating the fact of evolution, but an adequate study of morphological adaptation should contribute to a solution of the problem of the *nature* of evolution. And morphologists cannot afford to ignore that it is precisely the problem of the nature of evolution that is at the bottom of most modern experimental research; interest has shifted from what has happened to *how* it happened.

In the ecologic section of Dr. Walls' book the eye is not considered merely as an organ that has suffered certain alterations during its evolution from the cyclostomes to the mammals—changes which, however real and however important, have revealed little as to their underlying causes beyond an appeal to innate perfecting mechanisms and the like. Instead, the eye is considered as a structure that has adapted itself to the specific requirements of its owner, *within the rigid limits set by the phylogenetic level of that owner*. In short, adaptation is superimposed upon phylogeny, and to a considerable extent is limited by it; hence the importance of a knowledge of phylogeny (progressive evolution) as a background for interpretation of adaptive evolution. Thus, to cite a simple example, the author points out (p. 412) that the whale's eye is a terrestrial vertebrate's eye made over into an imitation of a fish's eye. Again, it is something of a shock to learn (p. 689) that the human eye has only secondarily become as "good" as the eye of the reptilian forebears of mammals, by the slow process of re-differentiation of, and substitution for, the important structures that man's placental ancestors had given up as unnecessary. Evolution thus emerges as a sort of phylogenetic tug-of-war, with the conservative forces of heredity pulling valiently in one direction (to preserve the status quo) while the radical forces of adaptation tug in the opposite direction. Perhaps nowhere is the mauling to which organs are subjected by this inter-action better revealed than in the history of the eye.

Walls, by avoiding the inviting but dangerous by-ways of speculation as to the why of the adaptations with which he deals, has escaped the pitfall much talked of by experimental zoologists: teleology. Functional correlations and specific adaptations are presented for what they are worth; further speculation is left to the discretion of the reader.

It happens that *The Vertebrate Eye* provides a spectacular example of the contrast between the older analytical approach to morphology and the newer synthetic approach. Less than ten years ago Victor Franz, himself an outstanding student of the vertebrate eye, reviewed exactly the same literature for the Bolk-Göppert-Kallius-Lobosch *Handbuch*. Franz produced a monumental (and, to a non-ophthalmologist, extraordinarily uninspiring) compendium arranged within the classical framework of comparative anatomy. His book is a mine of factual data, of vital interest to anyone working on the eye—but of little use to anyone else. By contrast, *The Vertebrate Eye* bristles with ideas that stimulate and challenge the phylogenist, the ecologist, the animal behaviorist, the physiologist—even the philosopher and the geniticist! What better proof is needed that morphology is ready and able to participate in the modern trend toward synthesis that seems to be replacing the older analysis in biological research? If the trend in biology is toward re-integration of the fragments into which our fathers and grandfathers sundered the field, then the intriguing study of functional, adaptive morphology is an answer for those whose fingers itch for the scalpel and microtome instead of for the breeding bottle or the endless transplantation of pituitaries.

In my opinion the general significance of this book far transcends whatever merit it may have as an excellent reference work on the eye. It is not the first large-scale attempt to apply the dynamic principles of adaptation to morphology. The seed sown by such pioneering works as Abel's *Palaeobiologie* (1912) had already borne fruit. Sewertzoff's *Morpho-*

logische Gesetzmässgkeiten der Evolution (1931) and Böker's *Einführung in die vergleichende biologische Anatomie* (1935–37), for example, both tackled this problem on an even wider front. But Sewertzoff's work is more a philosophical *tour de force* than a morphological study, and Böker's book suffers from its author's extraordinarily naive attitude toward modern genetics and the generally superficial nature of his treatment. Walls' book, on the contrary, reflects its author's complete mastery of both fact and theory in his own and related fields, and this is combined with a seasoning of intelligence and imagination to provide an excellent sample of what the future may bring in the field of what Böker has called "comparative *biological* anatomy." For this reason I regard *The Vertebrate Eye* as a really important work from the general biological standpoint.

The Cranbrook Institute of Science is to be congratulated for the physical appearance of the book, which is beautifully and durably made. The price, for a volume of this size and quality, is extraordinarily low.—D. Dwight Davis.

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COMMENT AND NEWS

TWENTY-FIFTH ANNUAL MEETING

It is planned to hold the twenty-fifth annual stated meeting of the American Society of Mammologists at the Carnegie Museum, Pittsburgh, Pennsylvania, from Tuesday, April 27, to Saturday, May 1, 1943, war restrictions at that time permitting.

The Local Committee on Arrangements is comprised of J. Kenneth Doutt *Chairman*, Sidney K. Eastwood, R. L. Fricke, A. W. Henn, Miss Caroline A. Heppenstall, E. J. House, M. Graham Netting, John M. Phillips, and Lawrence C. Woods.

HAMILTON IN SANITARY CORPS

William J. Hamilton, Jr. has been commissioned a Captain in the Sanitary Corps of the U. S. Army. He is stationed (September) at Fort Sam Houston, Texas.

DAVIS RETURNS FROM MEXICO

W. B. Davis and a group of 24 students from Texas A. and M. returned September 7 from three months of field work in Mexico. Numerous specimens of birds, mammals, fish, and plants were collected.

STIRTON RETURNS FROM SALVADOR

R. A. Stirton and a group from the University of California returned in early June from several months of collecting in Salvador. Due to war conditions they were forced to return overland by way of Honduras and Mexico. Good series of birds and mammals were preserved.

SANDERSON AFFILIATED WITH AUDUBON SOCIETY

There are few, if any, members of this Society who have concerned themselves more effectively with the conservation of mammals than has Wilford E. Sanderson. As Director of the Wildlife Department of the American Humane Association he has for many years been active in field investigations, in efforts to adjust the needs of the trapping industry with a reduction of needless suffering, and in effecting the passage of sound conservation legislation. In all of these projects he has been signally successful. Not the least noteworthy fact is that he has been able to gain and to retain the liking as well as the respect of those opposing his projects.

It is with great satisfaction that we are able to report that the National Audubon Society has added Mr. Sanderson to its staff. This is a reliable indication that the N. A. S. will now increase its mammal work to a very considerable degree, as it has been desirous of doing for some time.

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